file with Supplemental attic

SUPPLEMENTAL NATIONAL AERONAUTICS AND SPACE ADMINISTRATION APPROPRIATIONS, 1960

THE UNIVERSITY OF MICHIGAN

MAR 3 1960

MAIN READING ROOM

HEARINGS

BEFORE THE

SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

SECOND SESSION

SPECIAL SUBCOMMITTEE ON DEFICIENCIES

ALBERT THOMAS, Texas, *Chairman*

MICHAEL J. KIRWAN, Ohio
JOHN J. ROONEY, New York
EDWARD P. BOLAND, Massachusetts
BEN F. JENSEN, Iowa
FRANK T. BOW, Ohio
CHARLES RAPER JONAS, North Carolina

G. HOMER SKARIN, *Staff Assistant to the Subcommittee*

Printed for the use of the Committee on Appropriations

UNITED STATES
GOVERNMENT PRINTING OFFICE
51510 WASHINGTON : 1960

COMMITTEE ON APPROPRIATIONS

CLARENCE CANNON, Missouri, *Chairman*

GEORGE H. MAHON, Texas
HARRY R. SHEPPARD, California
ALBERT THOMAS, Texas
MICHAEL J. KIRWAN, Ohio
W. F. NORRELL, Arkansas
JAMIE L. WHITTEN, Mississippi
GEORGE W. ANDREWS, Alabama
JOHN J. ROONEY, New York
J. VAUGHAN GARY, Virginia
JOHN E. FOGARTY, Rhode Island
ROBERT L. F. SIKES, Florida
PRINCE H. PRESTON, Georgia
OTTO E. PASSMAN, Louisiana
LOUIS C. RABAUT, Michigan
SIDNEY R. YATES, Illinois
FRED MARSHALL, Minnesota
JOHN J. RILEY, South Carolina
JOE L. EVINS, Tennessee
JOHN F. SHELLEY, California
EDWARD P. BOLAND, Massachusetts
DON MAGNUSON, Washington
WILLIAM H. NATCHER, Kentucky
DANIEL J. FLOOD, Pennsylvania
WINFIELD K. DENTON, Indiana
TOM STEED, Oklahoma
HUGH Q. ALEXANDER, North Carolina
ALFRED E. SANTANGELO, New York
JOSEPH M. MONTOYA, New Mexico
GEORGE E. SHIPLEY, Illinois

JOHN TABER, New York
BEN F. JENSEN, Iowa
H. CARL ANDERSEN, Minnesota
WALT HORAN, Washington
GORDON CANFIELD, New Jersey
IVOR D. FENTON, Pennsylvania
GERALD R. FORD, JR., Michigan
HAROLD C. OSTERTAG, New York
FRANK T. BOW, Ohio
CHARLES RAPER JONAS, North Carolina
MELVIN R. LAIRD, Wisconsin
ELFORD A. CEDERBERG, Michigan
GLENARD P. LIPSCOMB, California
JOHN J. RHODES, Arizona
JOHN R. PILLION, New York
PHIL WEAVER, Nebraska
WILLIAM E. MINSHALL, Ohio
KEITH THOMSON, Wyoming
ROBERT H. MICHEL, Illinois
SILVIO O. CONTE, Massachusetts

KENNETH SPRANKLE, *Clerk and Staff Director*

DEPOSITED BY THE
UNITED STATES OF AMERICA

SUPPLEMENTAL NATIONAL AERONAUTICS AND SPACE ADMINISTRATION APPROPRIATIONS, 1960

MONDAY, FEBRUARY 1, 1960.

WITNESSES

DR. T. KEITH GLENNAN, ADMINISTRATOR
DR. HUGH L. DRYDEN, DEPUTY ADMINISTRATOR
DR. ABE SILVERSTEIN, DIRECTOR SPACE FLIGHT PROGRAM
GEORGE LOW, PROGRAM CHIEF, MANNED SPACE FLIGHT
MAJ. VICTOR HAMMOND, USAF, TRACKING AND DATA ACQUISITION PROGRAM
COL. D. L. HEATON, TECHNICAL ASSISTANT TO THE DIRECTOR LAUNCH VEHICLE PROGRAM
RALPH ULMER, BUDGET OFFICER

Mr. THOMAS. Gentlemen, the committee will please come to order

SUPPLEMENTAL ESTIMATE, 1960

We shall insert at this point the appropriate portion of the budget message contained in House Document 301 for the National Aeronautics and Space Administration.

(The matter referred to follows:)

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., January 18, 1960.

The PRESIDENT,
The White House.

SIR: I have the honor to submit herewith for your consideration proposed supplemental appropriations for the fiscal year 1960, in the amount of $23 million for the National Aeronautics and Space Administration, as follows:

"INDEPENDENT OFFICES

"NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

"RESEARCH AND DEVELOPMENT

"For an additional amount for "Research and development", $12,200,000, to remain available until expended.

"CONSTRUCTION AND EQUIPMENT

"For an additional amount for "Construction and equipment", $10,800,000, to remain available until expended."

The foregoing proposed supplemental appropriations are to expedite space activities and functions being undertaken pursuant to the National Aeronautics and Space Act of 1958. The sum of $12,200,000 is to further research and development for the early achievement of manned space flight and recovery. The sum of $10,800,000 is for construction and equipment of an additional launching pad

for ATLAS based space vehicles at the Atlantic Missile Range and of additional improvements to the MERCURY manned space flight tracking network. The submission of these estimates for fiscal year 1960 was anticipated in the 1961 budget document, and the amounts are within the totals authorized for the fiscal year 1960 by Public Law 86–45.

I recommend that the foregoing proposed appropriations be transmitted to the Congress.

Respectfully yours,

MAURICE H. STANS,
Director of the Bureau of the Budget.

We have with us this morning a distinguished group of gentlemen and friends who are well and favorably known to the committee from the National Aeronautics and Space Administration.

Welcome aboard, gentlemen. It is nice to see you all.

Dr. Glennan, do you have a statement you would like to make to us?

GENERAL STATEMENT

Dr. GLENNAN. Mr Chairman, I do have a statement that I would like to read briefly to you.

Mr. Chairman and members of the committee, I want to thank you for this opportunity to present NASA's request for a $23 million supplemental to the fiscal year 1960 budget of $500,575,000.

May I take this opportunity to say that I have enjoyed the cordial relationship that has developed between our agency and the members of the Appropriations Committee during the 15 months of NASA's operational existence. The extensive experience of the chairman, Mr. Thomas, in dealing with the research and development activities of a number of the independent agencies has made his advice particularly valuable to us.

With me today are members of our administrative and technical staffs who are prepared with item-by-item details of the supplemental request for funds submitted by NASA. After the supplemental request presentations, I would like to have enough time to discuss with the subcommittee a matter relating to the staffing of our agency.

I want to assure the subcommittee that NASA has made a very real effort to live within its $500,575,000 budgetary limit. However, space exploration involves a highly dynamic, rapidly changing, and expensive technology now in the very early pioneering stages of development. This supplemental request covers, for the most part, needs resulting from technological developments in Project Mercury, the first phase of the Nation's manned space flight program.

It is my belief, based on discussions with responsible members of our staff, that inability to fund necessary modifications during fiscal year 1960 will result in a serious slowdown of this project which has had the Nation's highest priority—a DX rating—since April 1959. It would be no exaggeration to say that the immediate focus of the U.S. space program is upon this project.

Of the $23 million requested, $19 million is urgently needed for Project Mercury. The balance of the request—$4 million—is for modifications to a launch pad at the Atlantic Missile Range to accom-

modate the Atlas-Agena B and other advanced launch vehicles. The supplemental breaks down as follows:

$12,200,000 under "Research and development" for Project Mercury.

$10,800,000 under "Construction and equipment," of which $6,800,000 is for the Mercury tracking and data-collection network, and $4 million is for the launch pad modifications.

NASA's fiscal year 1960 budget provides a total of $74,962,000 for Project Mercury. During calendar year 1960, the major part of the Mercury preflight and flight development program will be completed; component qualification and astronaut training flights will have been initiated.

During calendar year 1961, the Mercury qualification programs will be completed and the tracking network will become operational. If we do not experience delays or major developmental setbacks, it is our aim to place a man in orbit during calendar year 1961.

If NASA is to meet its Mercury deadlines, we must have an additional $12,200,000 in "Research and development" to cover improvements in the Mercury capsule's design, construction, and instrumentation. The need for these modifications has arisen as the result of NASA's rigorous developmental tests and continuing analysis of safety requirements.

Let me give you some examples of what I mean. The original capsule had two hatches, one in the top and one on the side. The side hatch was bolted. We are now making it possible for the side hatch to be triggered from the inside by the pilot, much as a canopy is blown from a jet fighter plane. It would be used only in emergencies. We are also redesigning the instrument panel to make fuller utilization of the pilot's capabilities, and installing a large window, in place of a small porthole, to increase visibility for the pilot. This window also allows him to see the horizon during the retrorocket firing period, hence aiding him to navigate. We are adding an inflatable impact bag to ease landing shock.

The supplemental also covers the following improvements:

Instrumentation to provide a more powerful communications system for the pilot.

An alternate reaction control jet system which may prove more efficient than the present system and be substituted therefor.

Six additional Mercury capsules, bringing the total to 20. These are being procured because our tests and analyses have shown that it is more economical to buy new capsules than to rebuild them after test flights.

A "rate-damping" installation in the manual control system to cut down on capsule oscillation and make the pilot's job easier when he chooses to use the manual controls.

Considerable additional flight monitoring and telemetry equipment for the Mercury installation at the Atlantic Missile Range. This equipment is vitally needed for the manned Redstone flights this year.

Modifications of this nature are bound to arise in such top priority compressed-schedule projects wherein research, development, design, and fabrication must go forward simultaneously. The same situation holds, to some extent, for the tracking and data-collection network item.

The most recent review of MERCURY network construction progress revealed the need for additional funds if the network is to become operational on schedule. The $6,800,000 request will provide the following:

Supplemental instrumentation and facilities at the 16 MERCURY stations, including the MERCURY control center at the Atlantic Missile Range.

Facilities at the U.S. Navy's Pacific Missile Range, Point Arguello, Calif., and its Kauai Island installation in Hawaii. These 2 installations will become part of the 16-station network in place of 2 Air Force installations which, it now appears, must be kept free for the Defense Department's DISCOVERER program.

Recent studies have shown that a decision to abort the MERCURY mission must be made at AMR within a shorter time span than had been previously estimated if the capsule is to come down on the Atlantic Ocean as desired, and not land in Africa. This situation places greater dependence on the MERCURY installation at AMR requiring considerably more equipment.

Finally, the launching pad which will undergo modification at AMR is pad 12, now being used by the Air Force for ATLAS firings. To accommodate the ATLAS-AGENA B, which is scheduled for initial launchings in late spring or early summer of 1961, considerable ground support equipment must be provided. Also needed are a new umbilical tower tall enough to service the extended rocket vehicle, and a repositioning of the working platform to suit the AGENA B's particular needs.

The ATLAS-AGENA B and the ATLAS-based CENTAUR are vital to the Nation's space program in the coming years. The ATLAS-AGENA B, for example, will be capable of launching a spacecraft of several thousand pounds on a 300-mile orbit or a spacecraft of several hundred pounds on a lunar trajectory.

Before requesting my associates to explain the program changes in more detail, let me stress again my belief that the proposed supplemental for fiscal year 1960 is vital to the urgent prosecution of the U.S. space program. As the members of this committee know, NASA is almost wholly a research and development operation, with all the uncertainties and unforeseen problems that such an operation entails. Our program requires constant review and revaluation.

Again, gentlemen, I express to you my appreciation for this opportunity to discuss our program and to present the supplemental request.

Mr. THOMAS. That is a good, short statement. It covers the waterfront.

PERSONNEL CEILING

Doctor, you wrote a letter to the committee suggesting the removal of the current NASA personnel limitation to permit the employment of 150 employees in the headquarters office here in the District of Columbia. Address yourself to that. You do not need any money. You want to transfer funds from other salary and expense items to salaries for 150 additional personnel in the headquarters. Address yourself to that.

Dr. GLENNAN. I have another statement on that, Mr. Thomas. (The statement follows:)

Mr. Chairman and members of the committee, in my letter of recent date I indicated the necessity of increasing by 250, NASA's fiscal year 1960 personnel ceiling of 9,836. I would like to take this opportunity to explain the nature of this increase in some detail.

The agency has determined the need to recruit and assign 100 employees to NASA's Huntsville, Ala. facility where high-thrust rocket vehicle development will be concentrated. The remaining 150 individuals are needed for our headquarters staff here in Washington, D.C., bringing it to a total of 683.

The proposed increase can be carried out within the fiscal year 1960 "Salaries and expenses" appropriation of $91,400,000, thanks to certain flexibility within the S. & E. item which I will discuss later. Furthermore, this increase represents an advance recruitment of positions already included in the fiscal year 1961 budget request, hence it is not a special increment. Let me repeat that statement: This increase in position ceilings represents advance recruitment of positions included in the fiscal year 1961 budget request which has already been submitted to the Congress.

The requirement for an immediate increase in personnel is the inevitable outgrowth of NASA's greatly expanding programs. In certain areas this expansion has placed a crushing burden on technical and administrative personnel.

Most notable expansion in NASA's mission is in the field of superboosters. In late 1959 the President ordered the transfer to NASA of the Development Operations Division of the Army Ballistic Missile Agency at Redstone Arsenal, Huntsville, Ala., along with SATURN, the 1,500,000-pound-thrust (clustered) rocket engine under development by the division.

Subject to congressional approval, the transfer will become effective 60 days from formal notification of the Congress on January 14 last; it will include the 4,300 scientific and technical positions from the present Development Operations Division and a provision enabling NASA to recruit up to 815 individuals from ABMA or Redstone Arsenal supporting personnel. The total supporting personnel requirement of 1,200 for Dr. Wernher von Braun's group cannot be filled entirely from the Redstone personnel because the Army requires their continued service in military programs.

The 100 persons we plan to recruit now are desperately needed at Huntsville to plan for the NASA takeover so that it goes smoothly and does not disrupt either Army or NASA programs.

The President's assignment to NASA of sole responsibility for developing high-thrust boosters, regardless of their ultimate military or nonmilitary uses, took place last year. This mission, as I have said, is adding heavy workloads to NASA's headquarters staff in all divisions.

Prior to that assignment, the fiscal year 1960 authorized strength in the Office of Space Flight Development was 113. With this added mission came the requirement for a total of 170 individuals in all phases of space flight development.

In order to speed development of superboosters, therefore, we decided to split up the Office of Space Flight Development into two Offices, the Offices of Space Flight Programs and the Office of Launch Vehicle Programs with a total of 170 positions, 110 in the former and 60 in the latter.

The Huntsville group, and NASA launch operations at the Atlantic Missile Range and later, the Pacific Missile Range, will report to the Office of Launch Vehicles Programs.

Let me review briefly the divisions under the new organization. They include:

The Office of Advanced Research Programs (formerly the Office of Aeronautical and Space Research) which is charged with advanced research in aeronautics and space. Under this Office, NASA's research centers have been undergoing a major transformation in function from aeronautics and rocket research to the most advanced space research, all within existing personnel complements. There is a premium on headquarters personnel with knowledge in specific research areas; more specialists and clerical help are needed. This Office would increase by 12 from 83 to 95.

The Office of Space Flight Programs (formerly the Office of Space Flight Development) which is responsible for mission planning, payload design and development, and in-flight research and operation. As boosters get larger, payloads increase tremendously in size and complexity, adding to the pressures on scientists and engineers in the evaluation and mission-planning phase. This Office would grow to 110 positions, an increase of 30.

The Office of Launch Vehicle Programs, which I have mentioned earlier, would grow by 27 to a total of 60.

The Office of Business Administration, continues with the same name and functions. It devolves upon this Office to pull together into an efficient whole, NASA's variegated offices and research center operations. Additional personnel are required in systems accounting and budget analysis, and audit and procurement, for example. Again, the Huntsville transfer is an important factor in the increased personnel need. Increase in this Office would be 52 for a total of 271.

I would also like to touch upon the needs of my own staff in the Office of the Administrator, an increase of 29 positions for a total of 118. The new positions are in areas including international programs, the General Counsel's Office, program planning, and public information.

In conclusion, may I point out that NASA—providing its budget request for fiscal year 1961, and the transfer of the Von Braun operation are approved—will be planning, contracting for, and carrying out a program which will involve the commitment of $300 million more in fiscal year 1961 than in fiscal year 1960. It will involve the management of an organization which has suddenly been increased by more than 5,500 employees. This additional workload must be carried by someone, if a responsible and competent job is to be done.

I hope this rundown has been useful. My associates and I are prepared to discuss this situation in more detail and to answer questions by the subcommittee.

Mr. THOMAS. Address yourself first, Dr. Glennan, to your request for an increase in your personnel ceiling, please. It was written into the report on the 1960 appropriation bill that your ceiling was 9,836, an increase of 875 over the preceding year. You are now requesting 250 additional positions. This breaks itself down to about 100 in Huntsville and 150 in the District of Columbia.

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. There is no fresh money requested. It is merely a transfer of funds—the diversion of some of your expense money for personnel.

Dr. GLENNAN. That is right.

Mr. THOMAS. I would imagine that the committee would look with great sympathy upon most anything Von Braun's team is going to need down in the field, but we would like to look over with some degree of detail putting 150 additional men here in the District of Columbia.

Of course you do not have a laboratory here in the District; do you?

Dr. GLENNAN. This request for 150 people does not involve any increase in staff in the laboratories. There is a laboratory, as you know, in Greenbelt, Md., which we will have beneficial occupancy of, I believe, this year.

Mr. THOMAS. This does not go in that at all.

Dr. GLENNAN. No, sir.

EXCEPTED POSITIONS

Mr. THOMAS. Your act gives you 260 or 270 excepted positions.

Dr. GLENNAN. 260 excepted positions.

Mr. THOMAS. Plus 10 for what?

Dr. GLENNAN. There are 260, including the 10; 250 excepted positions with a ceiling salary of $19,000, plus 10 with a ceiling salary of $21,000.

Mr. THOMAS. What grades are those excepted positions at $19,000?

Dr. GLENNAN. They are not designated by grades; the salary level runs from $14,000 to $19,000.

Mr. THOMAS. What I am getting at is this: It is up to $19,000. You can start them in at 13's and 14's. Why call them excepted positions until you get to 18? Eighteen is 17.5, the highest in the classification grade. Above that is your excepted position. Eighteen's are about 17.5.

Mr. ULMER. We did have some supergrade positions in grades 16 and 17.

Mr. THOMAS. I thought I saw some 14's and 15's in your justification.

Mr. ULMER. $14,000 and $15,000. I am talking about the civil service grades under NACA. At the time NACA became NASA it was determined that those positions would have to fit within the 260 excepted positions provided by the basic NASA Act.

Mr. THOMAS. I do not think the committee is going to quibble with you about your scientific personnel. When you go loading down your agency with 25 or 30 public relations men to get out here and issue public releases every day and breathe down the neck of your scientists and get them all jittery and jumpy, that is something else.

BUSINESS OFFICE

Tell us about your business office. You want a 52 increase in that.

Dr. GLENNAN. Yes, Mr. Chairman. I think one has to look at the problems that arise when one adds $300 million or $400 million a year in new obligational authority, the bulk of which will go out in contracts with industry and some educational institutions. It takes intelligent people to see to it that we spend that money properly.

Mr. THOMAS. Is that work contracted for here in the District of Columbia or is Von Braun's team doing it?

Dr. GLENNAN. Some portion of it is. Von Braun will do some portion of it. Some small portion is done in some of the other centers but the overall management is a headquarters function.

OFFICE OF CONGRESSIONAL RELATIONS

Mr. THOMAS. An assistant administrator for congressional relations—what in the world do you want eight men over here in congressional relations for? Do they answer letters? If they answer letters you do not want two excepted positions at $15,000 and $19,000 a year, do you?

Dr. GLENNAN. They are there now, sir. However, there are only four men and the others are secretarial.

Mr. THOMAS. Are you not on the lush side? Do you know of any other agency in Government that has a man contacting Congress in an excepted position of $19,000? I know of none.

Dr. GLENNAN. We deal with eight committees of Congress. Both the Department of Health, Education and Welfare and the Department of State have men in these positions at $20,000.

OFFICE OF GENERAL COUNSEL

Mr. THOMAS. Office of the General Counsel. You want to increase that up to 33 jobs. We do not object to your paying your General Counsel $20,000 but I do not know of any other agency in the Government that pays their general counsel $20,000. I doubt if even the Defense Department does.

Dr. GLENNAN. The General Counsels of the Defense Department, and the Department of Health, Education, and Welfare are at this rate.

OFFICE OF INTERNATIONAL PROGRAMS

Mr. THOMAS. Those are departments of Government headed by a Cabinet officer. Office of International Programs jumps up from 7 to 10.

Dr. GLENNAN. We are doing a tremendous amount of work in the international area. This is one of the real bright spots in our program. The effectiveness with which we are countering the Russian spectaculars by this kind of straightforward, open dealing with people in the international field——

Mr. THOMAS. What would 10 people do in that regard? You have four excepted positions.

Dr. GLENNAN. Dr. Dryden is very active in that field and I think perhaps he might say something on that.

Dr. DRYDEN. There is only one excepted position, the number of excepted positions does not increase; the increase of three is for two clerks, and one additional programs officer.

Mr. THOMAS. There is only one excepted position?

Dr. DRYDEN. There is only one excepted position.

Mr. THOMAS. Three others are 15's. What are their duties?

Dr. DRYDEN. For example, the programs officer on operating requirements is the one working with the State Department in the negotiation of contracts with other countries for locating tracking stations, and for getting agreements with those countries for their operation. The programs officer on cooperative programs will deal with the general management of the cooperative programs for which arrangements have already been made with scientists from other countries.

Mr. THOMAS. Are these people engineers, lawyers, or what?

Dr. DRYDEN. No, sir. The scientific work in all of our cooperative programs is done by the scientific branches of the organization. These are the people handling the administrative aspects of the programs.

Mr. THOMAS. Does the State Department really not do your work?

Dr. DRYDEN. We have to tell the State Department what we want and what we need. We have to send people to foreign countries with their teams. The two or three people at the top in this unit are away from Washington with State Department teams a good deal of the time.

OFFICE OF BUSINESS ADMINISTRATION

Mr. THOMAS. Office of Business Administration goes up from four to six. You have three excepted positions in there already. What is the total employment in this office?

Dr. GLENNAN. 271 I believe is the total employment proposed for this office.

Mr. ULMER. 219 are currently authorized.

Mr. THOMAS. Management Analysis jumps from 13 to 15. That is part of the business administration setup, is it not?

Dr. GLENNAN. It is part of the Office of Business Administration.

Mr. THOMAS. What is the total in the agency of business administration? Is that 273?

Mr. ULMER. It is going from 219 to 271.

Dr. GLENNAN. Fifty-two more.

Mr. THOMAS. What do all of those 271 people do? Are they allocated in the District of Columbia?

Dr. GLENNAN. That is exactly right.

Mr. THOMAS. How many does Dr. von Braun have in the setup? How many do you have in your setup in the California laboratory?

Dr. GLENNAN. Dr. von Braun will have administrative support personnel to assist his technical staff.

Mr. THOMAS. I mean doing the same work, business administration, regardless of the 12 or 15 classifications.

Dr. GLENNAN. We can give you those figures. I don't have them with me at the present time.

Mr. THOMAS. Do you have an approximate idea?

Mr. ULMER. Approximately 10 percent of the staffs of all the centers are engaged in this overall area of administration; the functional areas include procurement and contracting, budget and fiscal, personnel, audit, security, management, and administrative services.

BUDGET AND FISCAL

Mr. THOMAS. Budget and fiscal jumps from 28 to 40. That is still part of your business setup?

Dr. GLENNAN. That is right, part of that 271.

Mr. THOMAS. You have two excepted positions in there.

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. How many people throughout the agency, in your laboratories and District of Columbia headquarters, are engaged in this particular type of work—budget and fiscal?

Dr. GLENNAN. Mr. Ulmer, this is your particular field. Would you guess how many people throughout the agency are involved in this? We can give you the exact figure later.

Mr. THOMAS. Give us an approximate figure.

Mr. ULMER. I would guess somewhere in the order of 150 to 200 people throughout the organization. This includes all the payrolling functions in the field, voucher examinations, travel payments, et cetera.

Mr. THOMAS. You do not issue your vouchers from the District of Columbia for Huntsville, do you?

Mr. ULMER. No, sir. They will be issued locally in Huntsville as they are now issued locally at each NASA field installation. Headquarters is primarily a policy and regulation group.

PROCUREMENT AND SUPPLY

Mr. THOMAS. If your laboratory crowd in Huntsville or California want to go out and make a contract for procurement of a gadget or piece of equipment, do they have to have approval of the Washington office to do it?

Mr. ULMER. At a certain dollar level.

Mr. THOMAS. What is the limitation?

Mr. ULMER. It varies, depending on the proposed type of contract to be employed.

Mr. THOMAS. Spell it out for us.

Mr. ULMER. In general, field installations may enter into contracts for items up to $100,000 without Headquarters approval. This level is under review at the present time.

Mr. THOMAS. The field has that authority without coming to Washington?

Mr. ULMER. Yes, sir.

Mr. THOMAS. Why do you need so many people in the Washington office?

Dr. GLENNAN. Mr. Thomas, we are running a business with 16,000 employees and 6 very large laboratories.

Mr. THOMAS. The Army is financing the Huntsville project until July 1.

Dr. GLENNAN. The financing comes from the Army.

Mr. THOMAS. You do not have 16,000 people then.

Dr. GLENNAN. We will have them as of July 1 and what we are asking in the Huntsville situation is advance——

Mr. THOMAS. This is 1960, not 1961.

Dr. GLENNAN. Yes, sir. We are asking authority for the advance recruitment of 100 people against the supporting complement of 1,200 people, which we will have there next year in order that we can make preparations to take over on July 1. We can't go down there overnight and say "All right; we are now running a laboratory of 5,500 people."

SECURITY PERSONNEL

Mr. THOMAS. Security jumps up from 20 to 23; Procurement and Supply Division goes from 36 to 44.

Dr. GLENNAN. You will find this increase pretty much all along the line except that you will find more of it I believe in the Office of Business Administration and the Office of Launch Vehicle Programs.

Mr. THOMAS. Total business jumps from 219 to 271. That is the business office, all in the District of Columbia?

Dr. GLENNAN. That is right. All of these are in the District of Columbia. I refer to the 150 we are talking about.

Mr. THOMAS. Powerplants goes from 14 to 16, structures from 14 to 16, materials from 4 to 6, research grants from 83 to 95.

Mr. ULMER. From 17 to 20. The 83 and 95 figures are totals for the Office of Advanced Research Programs.

RESEARCH GRANTS AND CONTRACTS

Mr. THOMAS. The Office of Research Grants and Contracts jumps from 17 to 20. Whom are these grants made to?

Dr. GLENNAN. Universities and other nonprofit institutions.

Mr. THOMAS. How much grant money did you have for 1960?

Mr. GLENNAN. $5 million.

Mr. THOMAS. Is there a limitation on the amount of money you can make to one institution?

Dr. GLENNAN. No, sir.

Mr. THOMAS. You can give them the whole $5 million?

Dr. GLENNAN. Yes, sir. We don't do it that way, of course. The biggest grant we have made is a half million dollars.

Mr. THOMAS. How many grants do you have as of today, or say January 1?

Mr. ULMER. Between 45 and 50, sir.

Mr. THOMAS. Can you insert in the record at this time to whom they are made and the amounts?

Dr. GLENNAN. We will be glad to do that.

(The information is as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Statement of selected research and development contracts ($50,000 or over)

Reporting installation: NASA headquarters.
Month and year: December 1959.

Program: Aeronautical and space research, research grants and contracts			1959 allotment, $3,028,000		1960 allotment, $4,950,000	
Contract No.	Purpose	Contractor	Obligations	Pending commitments	Obligations	Pending commitments
			Millions	*Millions*	*Millions*	*Millions*
NsG 1-59 (HS-52)	Molecular study	Yale University	$0.11			
NsG 5-59 (HS-87)	Investigations of forces between atoms, molecules, and ions.	University of Maryland	.06			
NsG 34-59 (HS-88).	Research associateship program.	National Academy of Sciences.	.35			
NsG 3-59 (HS-90).	Studies of performance and flow in test section of maximum mach number wind tunnels.	The Rice Institute	.11			
NsG 14-59 (HS-111).	Synthesis of high-order nonlinear control systems.	Rensselaer Polytechnic Institute.	.08			
NsG 8-59 (HS-121).	Determination of solar parallax.	Yale University	.11			
NsG 4-59 (HS-122).	Investigations of radar methods for exploring Moon and planets.	University of Michigan	.13			
NsG 10-59 (HS-125).	Reaction kinetics of accelerating flames.	University of California	.12			
NTF-45 (HS-138).	Assist Space Science Board.	National Science Foundation.	.11			
NsG 6-59 (HS-139).	Research in solid state physics.	Rice Institute	.50			
NsG 16-59 (HS-153).	Study of general instability of cylindrical shells.	University of Florida	.06			
NsG 17-59 (HS-159).	General instability in stiffened circular cylinders.	New York University	.12			
NASW-74 (HS-204).	Develop techniques for fabrication of refractory-coated metals.	T. R. Finn & Co	.10			
NsG 28-59 (HS-235).	Research on automatic control theory.	Purdue University	.20			
NsG 29-60 (HS-222).	Satellite and planetary motion.	Yale University	.15			
NsG 31-60 (HS-223).	Unstable aerodynamic flow and noise.	Massachusetts Institute	.07			
NsG 36-60 (HS-253).	Research on hybrid numerical circuitry.	Case Institute of Technology.	.18			
NsG 38-60 (HS-313).	Continuation of research on dispersion-strengthened materials.	Rensselaer Polytechnic Institute.			$0.06	

Statement of selected research and development contracts (\$50,000 or over)—Con.

Program: Aeronautical and space research, research grants and contracts			1959 allotment, \$3,028,000		1960 allotment, \$4,950,000	
Contract No.	Purpose	Contractor	Obligations	Pending commitments	Obligations	Pending commitments
			Millions	*Millions*	*Millions*	*Millions*
NTF-64 (HS-314).	Research on boundary layer transition.	Bureau of Standards (Commerce).			\$.07	
NsG 39-60 (HS-315).	Research on cavitation erosion phenomena.	University of Michigan			.09	
NsG 40-60 (HS-322).	Research on rarified gas flows.	California Institute of Technology.			.12	
NsG 43-60 (HS-352).	Research on celestial mechanics.	University of Cincinnati			.18	
HS-307	Research on long-range economic, social, political, and international aspects of space activities.	Rand Corp				\$0.02
NsG 44-60 (HS-355).	Parameters affecting detonation in gaseous mixtures.	Ohio State University			.11	
NASW-96 (HS-372).	Research study of implications of the use of space for peaceful and scientific purposes.	Brookings Institution			.10	
NsG 18-59 (HS-158).	Study of cylindrical and conical shells.	California Institute of Technology.	\$0.11			
NsG 50-60 (HS-397).	Study of ionization phenomena by high velocity molecular beams.	Colorado Seminary (University of Denver).			.12	
NsG 48-60 (HS-399).	Research on microwave gaseous electronics.	Rensselaer Polytechnic Institute.	.04		.01	
NsG 52-60 (HS-433).	Research for convection heat transfer in annular passages.	Stanford University			.07	
HS-449	Geochemical research on tektites, stony meteorites, and radioation damage in related silicate materials.	Mellon Institute				.10
HS-486	Investigation of flow and fracture of high-strength materials.	Catholic University of America.				.06
	Miscellaneous contracts (under \$50,000).		.32		.10	.10
	Total		3.03		1.03	.28

Mr. THOMAS. Can you without too much trouble read two or three of them into the record?

Mr. ULMER. Yes, sir. We have a contract for molecular study with Yale University; a contract on the investigations of forces between atoms, molecules, and ions with the University of Maryland; a study of performance and flow in test section of maximum mach number wind tunnels with the Rice Institute; the synthesis of high-order nonlinear control systems with Rensselaer Polytechnic Institute, et cetera.

LUNAR AND PLANETARY PROGRAMS

Mr. THOMAS. Lunar and planetary programs, 13 to 21. That is your total?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. What will these gentlemen do in the District of Columbia? They are not in the laboratories as I understand it.

Mr. GLENNAN. Dr. Silverstein.

Dr. SILVERSTEIN. This program is one of our most important programs and the functions of these people are varied. One of their most important functions is to provide the program guidance for the entire lunar and planetary program. This work is carried on both in our in-house laboratory activities and through contracts with industry and with the universities.

Mr. THOMAS. These are mostly scientists. You have 10 excepted positions there.

Dr. SILVERSTEIN. They are largely scientists, with the exception of the girls who perform stenographic work.

Mr. THOMAS. What are they doing? Do they not belong in the laboratory?

Dr. SILVERSTEIN. There is a need, with the widespread activity we have, with inputs coming to us from all sources and international inputs, to make sure that we do create an integrated and organized program. We can't do this with people who are not qualified.

Mr. THOMAS. Are you going to have a bunch of people in Washington telling Von Braun's crowd what to do and how to do it?

Dr. SILVERSTEIN. We are going to have people here who are going to examine the work of all centers, including his center. We will be doing work at his center as well as in industry. He will be taking charge of it in the launch vehicle area. We will have other people working on satellites and deep space programs. There needs to be a place where you bring this together with intelligence. Otherwise you have not an integrated national program but an assorted odds and ends program which doesn't stand up with any type of scrutiny.

Dr. GLENNAN. These people are involved not in telling a man how to do the program but in coming into agreement with him and the Administrator on the content of the program, some portion of which he is going to undertake. It is a coordinating staff job in which they do have some part in determining what Von Braun or the Lewis Center or the Langley Center will be doing but the manner of carrying this out is largely left up to——

Mr. THOMAS. Dr. Dryden, you are one of the most able teachers in this Government; when it comes to a Government scientist I do not put anybody above you and as an administrator you are tops too, but, I thought you told us years and years ago that these topflight scientists wore no man's collar and you could not put them in a pattern. You had to turn them loose if you were to get the full benefit of them. Here you have 13 or 14 men in Washington and the scientists are in the field.

Dr. DRYDEN. We were then talking about a research organization, working on research projects which were not intimately tied to vehicles, payloads, and their hardware which had to be brought together into a single system and fired off a launching pad.

I was going to remark that the use of technical men in this function is an expression of the belief on the part of all of us that the technical aspects of programs should be managed by technical people who understand and are competent in the program content. As Dr. Silverstein has described, the function of these people is to bring together the national picture as to what our scientific program ought to be; to discuss this and coordinate it at all of our centers and with the industrial people and others who are involved; to see that we are working on a unified program and not just on a miscellaneous collection of projects.

To do this it is necessary to have people like Dr. Newell and other people of his caliber here in Washington.

Mr. THOMAS. Our friend Dr. Newell out here who was at the Navy Laboratory?

Dr. DRYDEN. Yes; he is with us. He is the deputy to Dr. Silverstein.

Mr. THOMAS. When did you get Dr. Newell?

Dr. GLENNAN. In October 1958.

Mr. THOMAS. He is a good one.

Dr. DRYDEN. Yes.

Mr. THOMAS. I think he went to Russia about a year and a half or 2 years ago.

Dr. DRYDEN. He will be appearing before you in the appropriations hearings on exactly this aspect of the program.

OFFICE OF LAUNCH VEHICLE PROGRAMS

Mr. THOMAS. I am no scientist but I imagine you are going to have some mixup here. Take your vehicles group in your Office of Launch Vehicle Programs.

You go from 6 to 17. You have five or six excepted positions in here. What do they do in the District of Columbia? It appears to me that all these high-powered scientists ought to be out in the laboratory, not up here doing administrative work.

Dr. SILVERSTEIN. A program of this type is extremely complex. We are asked to develop a long-range program, say, extending 10 years into the future. There are inputs of this program from many sources. We get inputs from, say, the scientific body who are interested in knowing or seeing to it that our program includes the kinds of measurements that they want to make in the future. That is the Academy of Science group, the Space Science Board the educational institutions throughout the country. We are engaged in international programs. For example, currently we have a joint program with England in space work; we are working with six or seven other nations on training programs. In addition to that we are trying to put together from all of these sources a comprehensive national program which will in fact be a program that we can carry out over a long period of time in an integrated and uniform way. This can't be done with boys at headquarters. It takes men.

We get inputs from many sources and to evaluate these inputs takes good minds; to do it otherwise will be to end up with something that none of us would be proud of. We are spending quite a bit of money. It is very necessary that we spend this money intelligently and it can't be done with other than qualified people.

OFFICE OF PUBLIC INFORMATION

Mr. THOMAS. How do you justify public relations, which goes from 25 to 31 and now you want to go to 34?

Dr. GLENNAN. Mr. Chairman, this is one agency——

Mr. THOMAS. You have one excepted position here and four 15's, two 14's, and three 13's.

Dr. GLENNAN. Yes, sir. This agency is one which is in the public eye. The average number of calls per day to the public information people is somewhere in the neighborhood of 400 and an exactly similar

number of communications that come, with about 35 personal visits per day.

Mr. THOMAS. How many newspaper releases do you make a day?

Dr. GLENNAN. Less than three per week.

Mr. THOMAS. Do you have a staff down there advising the public that you are going to make a shot at 10 a.m. on Tuesday morning?

Dr. GLENNAN. The law requires us to be as completely frank and open with the public as we possibly can.

Mr. THOMAS. The law does not require you to tell the public in advance what you are going to do and get your scientists all under pressure with everybody breathing down their necks, cutting down their efficiency 50 percent. After it is an accomplished fact, then, I think, the law does put some responsibility on you to tell the public what is going on, but certainly not before.

Dr. GLENNAN. Mr. Chairman, if you could solve that problem for us, you would solve one of the most difficult problems we have.

Mr. THOMAS. No one can solve it except you. You are the Administrator.

Dr. GLENNAN. Actually we do not make announcements of our shots ahead of schedule. We do give the press a briefing about a week ahead of time on a "hold for release" basis, and usually they have respected that kind of information.

They get the information on which to prepare their stories. One of the great attributes of this program is the fact that we have been frank and open and rather prompt in getting out the information once the shot has been made.

The facts of the case are that the shots are made from Cape Canaveral which, as you know, is essentially open. There is not anything that can be done down there without some people knowing it. There are 20,000 people on that base, and somehow or other some of them talk to the press, so that the stories coming out of Canaveral really represent a good bit of the advance notice of which you are speaking.

There are two or three instances—such as the firings from Wallops Island of the sodium vapor trail rockets and the 100-foot balloon—where fear scares on the east coast have caused us a day before a flight to indicate that we plan to make a flight, but otherwise Wallops Island has been closed. You have not heard anything about any of the shots on the mercury capsule, for instance, until after the flight has taken place.

Mr. THOMAS. What do you need with these high-powered newspapermen. You pay them more than any other agency in the Government.

Dr. GLENNAN. I do not think so, sir. Unless we have this kind of support—and you will notice that you can buy as little or as much of it as you want—we will be spending the time of good scientists, to a much greater extent than we presently are, in answering these queries. We are a public agency and we are probably the one public agency outside the Defense Department about which these people most want to know.

Mr. THOMAS. You brought much of that on yourself by your own publicity.

Dr. GLENNAN. I would beg to differ with you on that in the sense that we are doing nothing except attempting to explain to the public what the money is being spent for.

The increase requested here is for three clerical positions below grade 13.

Mr. THOMAS. Let me suggest to you this; take about 3 of these 15 off the payroll and save about $50,000, and put your 3 clerical people on it.

Let us see how many story writers you have.

Dr. GLENNAN. We are required by the Congress to provide reports to the President and through the President to the Congress on three occasions during the year. We have information specialists for exhibits, and we have many exhibits that need to be made.

Mr. THOMAS. I have noticed it—and I have noticed it not once, but a dozen times—that your agency makes every edition every day of every paper, and that is not by accident.

Dr. GLENNAN. There are, as I say, Mr. Thomas——

Mr. THOMAS. That is through handout statements, and so forth.

Dr. GLENNAN. There are 35 visits from members of the press practically every day, and what they write——

Mr. THOMAS. Well, of course, you invited them there.

Dr. GLENNAN. I think it is simply a matter of interest that the American people have in this program. We cannot do without any of these people. I think in the course of a week we would be right in the soup. It is better that they get proper information than misinformation.

Mr. THOMAS. The Defense Department did not do this, and they have been in the space business longer than you have. The Air Force did not do it, the Navy did not do it, and the Army did not do it.

Dr. GLENNAN. Information on the VANGUARD project was released by the Department of Defense. We were not in business then. This was the Navy Department's operation, and the National Science Foundation. None of us—and I think I could say this, and the rest of my colleagues would agree with me—have any interest in being in the newspapers, I, least of all.

Mr. THOMAS. With that thought in mind, I would cut out some of this publicity, then, sir.

Dr. GLENNAN. We have controlled our own station, Wallops Island, so that there is not this sort of thing except in these shots where people may be frightened, and even this was not done until, after the first flight took place, the telephone lines were choked at various places along the east coast asking for information about it.

Mr. THOMAS. It is my understanding—you talk about Wallops Island and, perhaps, there is not too much complaint there—that you did get a lot of complaints from the Air Force people down at Canaveral. Am I wrong in that?

Dr. GLENNAN. We get some complaints.

Mr. THOMAS. I mean in this field of publicity here.

Dr. GLENNAN. We live entirely within the practices established by General Yates.

Mr. THOMAS. Well, I shall not quote the general.

Dr. GLENNAN. I was there.

Mr. THOMAS. I was, too.

Dr. DRYDEN. Canaveral is in full view of the public and, so, every time a space vehicle, a new, queer-looking shape is set up, everybody in the whole countryside knows about it as soon as it is on the launching pad. They can drive down the public highway and see it.

Mr. THOMAS. And, here comes the Space Agency with a release inviting the public to come in there and then comes the pressure on the poor scientists, and when you count it down, it does not go off, and there you are.

Dr. DRYDEN. Our people are under instructions to fire only when ready to fire regardless of what brass is present.

Mr. THOMAS. That is not the point. We are talking about publicity, Dr. Dryden.

Let us take a look at your request for funds here of $23 million.

MANNED SPACE FLIGHT PROGRAM

(MERCURY PROGRAM)

Dr. GLENNAN. Mr. Chairman, I would like, with your indulgence, to have Mr. Low explain briefly the present status of the MERCURY program, and then have Major Hammond to talk about the network which causes a larger portion of this request.

Mr. LOW. Mr. Chairman, I have——

Mr. THOMAS. Who is this?

Dr. GLENNAN. This is Mr. Low.

Mr. THOMAS. Where is the major?

Dr. GLENNAN. Major Hammond is back here; he will follow Mr. Low.

Mr. THOMAS. Tell us about yourself first, Mr. Low.

Mr. LOW. My present job, Mr. Chairman——

Mr. THOMAS. What is your background and experience? How long have you been with the agency?

Mr. LOW. I have been with NACA for about 9 years, and then transferred to NASA in the Washington office.

Mr. THOMAS. Where were you located in NACA?

Mr. LOW. I was located at the Cleveland Reseach Center, working for Dr. Silverstein.

Mr. THOMAS. Go ahead.

Mr. LOW. I have been in the NASA Washington office for a little over a year, and my position in this office is to coordinate the manned space flight program.

Mr. THOMAS. What is your scientific field?

Mr. LOW. I am an aeronautical engineer and specialized in boundary layer work, and in the area of heat transfer of bodies reentering atmosphere at high speeds.

Mr. THOMAS. The Cleveland laboratory did some outstanding work in that field and has done outstanding work in that field for years and the years.

Mr. LOW. Yes, sir.

Mr. THOMAS. Off the record.

(Discussion off the record).

How old are you?

Mr. LOW. Thirty-three, sir.

Mr. THOMAS. Wonderful.

Mr. JONAS. May I ask a question at this point?

Mr. THOMAS. Where did you go to school?

Mr. LOW. Rensselaer Polytechnic Institute.

Mr. THOMAS. When did you finish school?

Mr. LOW. I got my bachelor's degree in 1948, and my master's degree in 1950.

Mr. THOMAS. Wonderful. That is a remarkable record.

You have been with the agency since 1948?

Mr. LOW. Since 1949.

Mr. THOMAS. You came with the agency 11 years ago?

Mr. LOW. Yes, sir.

Mr. JONAS. You went straight to the agency when you got out of college?

Mr. LOW. Yes, sir.

Mr. THOMAS. Go ahead.

Mr. LOW. Project MERCURY, Mr. Chairman, is the Nation's program to orbit and recover a manned satellite. Its main objective is to determine the capabilities of man in a space environment. The project was conceived, and is being carried out, at a rate designed to achieve manned space flight at an early date.

My first chart shows the Project MERCURY capsule, together with the associated capsule systems. This includes a small package of solid propellant rockets which are used first to insert the capsule into orbit, and later on to get it back out of orbit.

It includes also an emergency escape system, which is used to separate the capsule from the ATLAS launching vehicle in case it should malfunction during the early stages of flight.

My next chart shows a cutaway view of the same capsule, revealing many of its engineering details. The shape of the capsule itself was determined from consideration of the aerodynamics, the heating, and the forces as the capsule comes back through the atmosphere. When the capsule comes back into the atmosphere, it will fly with the blunt end facing forward.

Mr. THOMAS. How far is the astronaut back from the nose cone?

Mr. LOW. His position is indicated here [indicating]. The ATLAS booster during launch fits at this end [indicating] of the capsule

Mr. THOMAS. It is going to be 75 feet long?

Mr. LOW. The overall length of the ATLAS plus the capsule is of that order.

Mr. THOMAS. Yes. He is right up there in the front; is he not?

Mr. LOW. Yes, sir.

I have a chart later on which shows one of the capsules on top of the ATLAS booster, which will illustrate it better.

Within the capsule the man is supported in a form-fitting couch that was developed so that he can withstand the g. forces during both the launch and reentry.

When the capsule reenters the atmosphere, the man will be pressed back into this couch with eight times the force of gravity. We have demonstrated in centrifuge tests that, in such a couch, man can withstand many more times the g. forces than he will have to tolerate in flight.

While in orbit the capsule will be stabilized or oriented about its axis. This is done, first of all, by sensing its attitude with a horizon scanner, and then by controlling the attitude about the capsule's axes with some small jets which are located at the top and bottom ends of the capsule.

Now, if everything works normally, this whole operation will be done automatically. But as a backup, we have an instrument panel and a periscope in order to give the man himself information on his attitude; and a manual pilot control stick which, again, activates these small jets in the capsule.

Also, there is an environmental control system to keep the atmosphere in the capsule within prescribed limits and a communications system as well.

Mr. THOMAS. Is that auxiliary to the ground control system?

Mr. LOW. The pilot control stick?

Mr. THOMAS. Yes, sir.

Mr. LOW. Yes; it is.

Mr. THOMAS. Upon which are you relying?

Mr. LOW. We are relying on both. The capsule can function completely automatically.

Mr. THOMAS. Who is the head of your control system and your guidance systems down at Huntsville?

Mr. LOW. I do not remember his name, sir.

Mr. THOMAS. Off the record.

(Discussion off the record.)

Mr. LOW. I will come back to a discussion of the instrument panel and the functions that the pilot can perform with my next chart, but I will quickly finish this one.

The capsule is brought back into the atmosphere by firing the small rockets that were shown on the first chart. This slows the capsule down by about 350 miles an hour. This is just enough so that the earth's gravity will reassert itself and the capsule will be pulled back to earth.

The final descent will be made by parachutes which are housed in the top end of the capsule. Initially, the capsule is slowed down by the drag of the air through which it flies from 17,500 miles an hour to a speed of, perhaps, 200 miles an hour; and at 200 miles an hour the parachutes are deployed to lower the capsule into the Atlantic Ocean.

There has been a great deal of discussion as to exactly what part the pilot should play in a space mission. It is our belief that the pilot's role should be an exceedingly active one, and that he can greatly enhance the reliability of the whole capsule system by being able to back up all the factors that normally are controlled automatically.

This chart, then, shows the instrument panel which he will use.

Mr. THOMAS. Where is this research and development work done? Is it done here in the District of Columbia, or is it done in California, or at Huntsville?

Mr. LOW. No, sir; the group which has the technical direction for MERCURY is the Space Task Group now located at Langley Field, Va. It is a part, organizationally, of the Goddard Space Flight Center which will be located at Greenbelt, Md., but is now housed at Langley Field, Va.

The key to the pilot's function is a sequence control panel illustrated here [indicating]. On this panel, there are a number of switches which will allow the pilot to perform each one of the functions in the flight sequence manually, in case the automatic sequencer does not perform them at the proper time.

For example, if the retrorockets should not fire automatically there is an independent circuit, or an independent mechanical system that the pilot himself can activate to fire those rockets.

The panel on the left has to do with the attitude controls. By pulling these handles, the astronaut can lock out the automatic

reaction control system and activate a manual system; then he can control the attitude of the capsule with his control stick. Another handle allows him to decompress the capsule and vent it to the outside vacuum, in case there should be a fire. In this way he can put out the fire. Of course, he will be in a pressure suit so that he can survive in the decompressed capsule.

When he flies with his control stick, he is guided by a number of flight instruments, including needles that show the capsule's orientation, a clock, a dead-reckoning instrument, and a periscope through which he sees the ground below him. With these references he will be able to control the capsule's attitude with his control stick.

The instruments over here [indicating] allow him to monitor the functioning of the life support system, the amount of oxygen remaining, and the partial pressure of carbon dioxiode. If the cabin's atmosphere deteriorates, the pilot will be able to control it.

These instruments [indicating] control the electrical and communications system. These [indicating] are a series of lights and buzzers which go on in case any of the systems do not function.

I think this whole picture shows the astronaut's participation in the flight will be a very active one.

Even by showing this complexity of the instrument panel, and the cutaway view of the capsule, I do not think I have fully demonstrated how complex this device really is.

Mr. THOMAS. Please do not any more. I am afraid we do not understand what you have covered.

Mr. LOW. I would like to make one point, though, which allows me to illustrate some of this:

There are within this capsule 7 miles of electrical wiring interwoven throughout the cabin to activate the various gadgets within the capsule. Seven miles of electrical wiring are required to make all the systems function properly.

A program such as this could not be carried out without a very extensive research and development program, and this was carried out concurrently with the construction of the capsule in order to accomplish this job at the earliest possible time. The research and development program included airplane drop tests of full-scale, "boilerplate" capsules in order to develop the parachute system. It included also tests of the escape system which were accomplished by launching the capsule with the escape system as the only means of propulsion. My next chart illustrates an escape test. At the top of the capsule you see the pilot's escape system which is used to get the pilot away from its booster in case it should malfunction. The capsule itself is launched with this escape rocket. At the peak of the trajectory the escape tower is jettisoned and a small parachute is deployed; and later, another parachute is deployed to lower the capsule toward the ocean.

We then carried out a rocket flight test program to determine whether the capsule's shape was proper, and to check the escape system and other factors that would be encountered in later flights To do this we launched a capsule with our so-called LITTLE JOE vehicle. This is a much smaller vehicle than the ATLAS that will be used to launch the capsule into orbit, and much more economical to operate; but it permits simulation of many of the conditions that would occur during an ATLAS launching.

The first LITTLE JOE launching was October 4, 1959. We had three more launchings since then, one in November 1959, one in December 1959, and one in January 1960, about a week and a half ago. All of these flights were quite successful and again helped us check out the all-important escape system.

Perhaps the most critical test to date of the MERCURY system was conducted in September 1959, using an ATLAS launching vehicle and a "boilerplate" capsule. This is a capsule that was made in our own shops, simulating completely the shape and weight of the final MERCURY capsule; but it did not have any of the important systems or subsystems that will be in the final capsule.

The purpose of this flight was to check at an early date the capsule's heat protection. The capsule was launched to nearly orbital speed, but then reentered the atmosphere without going into a satellite orbit. Subsequently it was recovered many hundreds of miles from Cape Canaveral. This flight was technically successful, and demonstrated that the heat shield of the MERCURY capsule is adequate for reentry from orbital flight.

This chart [indicating], Mr. Chairman, also illustrates, how the final MERCURY capsule will look on top of an ATLAS booster. The man will be located right here [indicating].

Now, during calendar year 1960 we will start a flight test program using the final production hardware built by McDonnell Aircraft Corp. In the summer of 1960 we will start qualifying the capsule using the REDSTONE booster. We will have a series of ballistic flights going to an altitude of 125 miles and to distances 200 miles from Cape Canaveral. These flights will first be with instrumented capsules only, and later on with a capsule containing an animal; and, finally, when we are completely satisfied that all systems are fully reliable, we will launch a man along this ballistic trajectory using the REDSTONE booster. This will allow us to subject both the man and the equipment to a period of 5.5 minutes of weightless flight; we believe that this experience is vital before we can fly a man into orbit.

Following the REDSTONE ballistic flights, the ATLAS booster will also be used to subject the capsule to the forces and heating that it will encounter along a series of different ballistic trajectories. Without going into detail, let me discuss the orbital mission which will also be carried out with the ATLAS booster. When the ATLAS launches the capsule into orbit, we will shoot for an orbital altitude of 120 miles. While in orbit, the speed will be 17,500 miles an hour. Each orbit around the earth will take about 90 minutes. We are planning to keep the capsule up for three orbits, or 4.5 hours. Again, in these flights we will initiate the program with instrumented flights to check the functioning of the capsule systems; we will then have animal flights to check the functioning of the life support system and to subject an animal to weightless flights of the order of 4.5 hours; and finally a manned flight will take place.

Our next chart shows some of the details of the flight mission. The capsule will be launched from Cape Canaveral in the direction toward Bermuda. The shaded areas on this map illustrate the planned recovery areas. Ships and airplanes will be deployed in all of these areas in order to pick up the capsule as quickly as possible after it lands. The five areas located between Cape Canaveral and the African coast will be used to pick up the capsule in case of an aborted

flight. If there is an indication on the ground, or in the capsule, that we cannot complete at least one revolution, then immediate action will be taken to bring the capsule down; it will then land within one of these five areas.

Emergency areas are also provided at the completion of the first and the second orbit. In a normal mission the landing will take place down range from Cape Canaveral after the third orbit.

After I am through Major Hammond will discuss the network of tracking and communications stations that will be situated under these flight paths to allow for communication to the ground, and also to monitor the flight path and determine the exact nature of the orbit.

Now, my last chart shows the flight schedule for Project Mercury.

I mentioned earlier that in the first half of fiscal year 1960 we had three LITTLE JOE flights and a fourth one in January of this year. We contemplate one more LITTLE JOE flight, using a production capsule built by McDonnell Aircraft Corp.

The REDSTONE program will start in the middle of this calendar year and will carry on for perhaps 1 year.

With the ATLAS we have had one flight early in September of last year, and we will continue with ballistic flights during the middle of this calendar year, and then go on with the orbital flights beyond that.

Mr. THOMAS. Fine.

Mr. JONAS. With reference to the first LITTLE JOE flight which has just been completed, what did you find necessary to change or what did not prove to be satisfactory, or are you planning any changes for the next flight?

Mr. LOW. Well, the first LITTLE JOE flight was in October, 1959; during this test we determined that the escape rocket did not fire quickly enough. This [indicating] is the escape rocket that fits on top of the capsule and which must carry the capsule away from a malfunctioning booster. During that flight ignition did not take place for some 7 or 8 seconds, while we expected it to take place in a small fraction of a second.

So we have gone back to our ground facilities and altitude chambers, and we have developed a new rocket ignition device which has worked better in subsequent flights. This is one particular example of what we found out.

Mr. JONAS. Do you think you have cured that defect or made that correction?

Mr. LOW. We have cured it, and we have had two more LITTLE JOE flights since then which proved to be successful.

Mr. JONAS. More satisfactory than the previous one?

Mr. LOW. Yes, sir.

Mr. JONAS. Did it come within the time limitation that you thought necessary?

Mr. LOW. Yes, sir; very definitely.

Mr. JONAS. On the subsequent flights, what did you discover that needed to be corrected, if anything?

Mr. LOW. The second LITTLE JOE flight included a planned escape maneuver at high altitudes. One particular item we discovered was that the escape rocket blast has an effect of sandblasting the astronaut's window. This did not occur at low altitudes but only at high altitudes.

Now, we do not know yet just how this will be fixed. If this window is sandblasted, then the astronaut has no view to the outside except through the periscope.

Mr. JONAS. Is that the window which was mentioned by Dr. Glennan?

Mr. LOW. Yes, sir. Initially, we had a small porthole located at about this position of the capsule. After the astronauts were selected and started working with the capsule and the mockup, they determined this porthole was very poor as far as visibility was concerned, and particularly it did not let them look at the horizon during retrofiring.

Mr. JONAS. What did you do with reference to the window?

Mr. LOW. We installed a bigger window, in a different location.

Mr. JONAS. Why does it take so much money to make that change? You already know what you want to do, and you have your plant and your people.

Dr. Glennan, I think, gave that as one illustration as to why he needed some more money.

Mr. LOW. The construction of a capsule like this stretches the state of the art at every turn of events. This capsule will fly at speeds almost 10 times faster than anything has flown before, and at altitudes 5 times higher, and will be subjected to heating which is much higher than ever encountered before. In the design of a window we must take into account the heating and the forces that will be encountered during the flight.

Mr. JONAS. In other words, you have to subject it to a lot of tests?

Mr. LOW. Yes, sir; we have to design it so that it can withstand the forces and the heating and then perform a tremendous amount of testing.

Dr. GLENNAN. Presumably, in changing the size and location of the window, other elements within the capsule head have to be moved higher and things of that sort, so that you have quite a flaring from what seems like a simple job of putting a window in.

You have a flaring out to a number of other subsystems which may require changes in cables, and so forth.

Mr. JONAS. You mean it is a little more complicated than just putting a glass window in your house?

Mr. LOW. Yes, sir; there is another point. In order to get on with the job and to do this job at the earliest possible time, we had to start the final design, and the final engineering, and the fabrication of this capsule at a very early date. Normally, in many programs there is a great deal of time between the date the design is laid out and before tooling and fabrication is started. We have had to do all of these steps concurrently.

Mr. JONAS. You do not have to rebuild the entire capsule, do you?

Mr. LOW. No, sir; but we do have to relocate some of this material.

Dr. DRYDEN. You have to change the parts that are already under manufacture. If this project were carried out in the normal sequence, you would not fly a man for 5 or 6 years. If you are going to fly him soon, you have to start building a capsule the way you think it should be now, and as the tests proceed, you have to go back and alter the capsules that are in the process of construction.

Mr. THOMAS. In other words, one change brings on a dozen others?

Dr. DRYDEN. Yes, sir.

Mr. LOW. One more point is that in lifting any device into space, weight is one of the most critical factors. If you do not have the booster capability to lift anything very heavy—this capsule weighs somewhat more than a ton, and we are still worried about every ounce and pound that goes into it—each item has to be designed as lightly as possible.

Mr. THOMAS. Let us take a look at the budget, and then we will let the major talk about the tracking system.

APPROPRIATION SUMMARY

At this point in the record we will insert page 1 of the justifications. (The page referred to follows:)

Fiscal year 1960 supplemental estimates—Appropriation summary

	Salaries and expenses	Research and development	Construction and equipment	Total
Approved, fiscal year 1959:				
Independent Offices Appropriation Act, 1959; Public Law 85-844	$78,100,000		$23,000,000	$101,100,000
Supplemental Appropriation Act, 1959; Public Law 85-766	5,000,000	$50,000,000	25,000,000	80,000,000
Second Supplemental Appropriation Act, 1959; Public Law 86-30	3,186,300			3,186,300
Transfers from DOD (72 Stat. 433)		154,619,532		154,619,532
Total	86,286,300	204,619,532	48,000,000	338,905,832
Approved, fiscal year 1960:				
Supplemental Appropriation Act, 1960; Public Law 86-213	91,400,000	335,350,000	73,825,000	500,575,000
Appropriation transfer; Public Law 86-213		−15,000,000	15,000,000	
Total	91,400,000	320,350,000	88,825,000	500,575,000
Requested, fiscal year 1960: Supplemental estimates		12,200,000	10,800,000	23,000,000

REQUEST FOR SUPPLEMENTAL FUNDS

Mr. THOMAS. For your salaries and expenses for 1960 you had $91,400,000. For research and development you had $335,350,000; you transferred from research and development $15 million to your construction account, which gave you $88,825,000, and a total budget for 1960 of $500,575,000.

Now, you are seeking a $23 million deficiency added to your $500,575,000.

The $23 million is broken down as follows: $12.2 million for research and development, and for construction and equipment $10.8 million, and I have written here on your $12.2 million request "Is this for salaries or equipment or both?"

RESEARCH AND DEVELOPMENT

At this point in the record we will insert pages 3, 4, and 6 of the green sheets.

(The pages referred to follow:)

Program and financing

	Presently available	Revised estimate	Difference
Program by activities:			
1. Aeronautical and space research:			
(a) Support of NASA plant	$11,500,000	$11,500,000	
(b) Research grants and contracts	2,000,000	2,000,000	
2. Space flight development and operations:			
(a) Support of NASA plant	4,000,000	4,000,000	
(b) Scientific investigations in space	45,000,000	45,000,000	
(c) Satellite applications	5,000,000	5,000,000	
(d) Manned space flight	50,000,000	52,500,000	+$2,500,000
(e) Vehicle development	90,182,980	90,182,980	
(f) Space propulsion technology	25,000,000	25,000,000	
(g) Vehicle systems technology	5,000,000	5,000,000	
(h) Tracking and data acquisition	11,000,000	11,000,000	
3. Program direction: Support of NASA plant	1,500,000	1,500,000	
Total program costs	250,182,980	252,682,980	+2,500,000
4. Supplies or services transferred in (−) without charge, net	−1,560,931	−1,560,931	
Total program costs, funded	248,622,049	251,122,049	+2,500,000
5. Relation of costs to obligations: Obligations incurred for costs of other years, net	132,946,972	142,646,972	+9,700,000
Total program (obligations)	381,569,021	393,769,021	+12,200,000
Financing:			
Comparative transfer from (−) Department of Defense	−55,182,980	−55,182,980	
Unobligated balance brought forward	−20,936,041	−20,936,041	
Advances and reimbursements from other accounts (−)	−5,100,000	−5,100,000	
Unobligated balance carried forward	20,000,000	20,000,000	
New obligational authority	320,350,000	332,550,000	+12,200,000
New obligational authority:			
Appropriation	335,350,000	335,350,000	
Transferred to "Construction and equipment, National Aeronautics and Space Administration" (Public Law 86-213)	−15,000,000	−15,000,000	
Proposed supplemental appropriation		12,200,000	+12,200,000

Object classification

		Presently available	Revised estimate	Difference
	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION			
03	Transportation of things	$1,485,000	$1,485,000	
04	Communication services	2,346,500	2,346,500	
07	Other contractual services:			
	Repairs and alterations	2,022,022	2,022,022	
	Miscellaneous services	154,487,332	162,687,332	+$8,200,000
	Services performed by other agencies	145,182,980	145,182,980	
08	Supplies and materials	60,000,000	61,000,000	+1,000,000
09	Equipment	16,000,000	19,000,000	+3,000,000
	Total, National Aeronautics and Space Administration	381,523,834	393,723,834	+12,200,000
	ALLOCATION ACCOUNTS			
07	Other contractual services	30,483	30,483	
09	Equipment	239	239	
10	Lands and structures	14,465	14,465	
	Total, allocation accounts	45,187	45,187	
	Total obligations	381,569,021	393,769,021	+12,200,000

Page 6 shows that $8.2 million of your $12.2 million under "Research and development" is for miscellaneous services; $1 million for supplies and materials, and $3 million for equipment, giving you a total of $12.2 million.

SUMMARY OF ACTIVITIES

What are your miscellaneous services? We will hold your answer until a little bit later, and put page 8 of the justifications in the record.

(The page referred to follows:)

Research and development—Summary

Program	Fiscal year 1959	Fiscal year 1960	Fiscal year 1960 supplemental
Aeronautical and space research:			
Support of NASA plant	$1,097,651	$22,684,000	
Research grants and contracts	3,028,000	4,950,000	
Support of JPL plant	[1] 8,156,500		
Scientific investigations in space:			
Sounding rockets	3,556,170	8,811,000	
Scientific satellites	21,305,114	23,813,000	
Lunar and planetary exploration	31,882,607	49,000,000	
Vanguard	[1] 21,943,582		
Satellite applications:			
Meteorology	987,550	7,930,000	
Communications	3,574,806	3,170,000	
Manned space flight	46,416,333	74,962,000	12,200,000
Vehicle systems technology	1,903,651	6,737,000	
Space propulsion technology:			
Solid rockets	615,898	3,785,000	
Liquid rockets	15,978,589	30,328,000	
Nuclear systems technology	3,810,496	6,000,000	
Space power technology		4,814,000	
Vehicle development:			
Scout	6,048,000	2,800,000	
Delta	12,927,417	13,300,000	
Vega	14,291,494	4,000,000	
Centaur	4,000,000	37,000,000	
Tracking and data acquisition	3,095,674	16,266,000	
Total	204,619,532	320,350,000	12,200,000

[1] Funded under program activities in 1960.

Mr. THOMAS. This shows that $12.2 million will be spent on your manned space flight.

MANNED SPACE FLIGHT

At this point in the record we will insert page 9 of the justifications, as well as pages 10, 11, and 12.

(The pages referred to follow:)

Fiscal year 1959	$46,416,333
Fiscal year 1960	74,962,000
Fiscal year 1960, supplemental	12,200,000
Fiscal year 1961	107,750,000

1. Objectives

To provide a capability for accomplishing advanced space flight missions with vehicles where onboard human intelligence and operations are required; to rationalize and refine the technology of manned space flight vehicles and associated systems; to achieve successful orbital flight and the recovery of a manned satellite with an ICBM booster and drag reentry system; to evaluate the physiological and psychological effects of a space environment on man; to establish his capabilities and limitations for performing useful missions in space; and to devise and develop improved manned vehicles with increased capabilities for performing important advanced missions.

2. Justification

The ultimate benefits that might accrue from manned space flight are, in a large measure, unknown. It is clear, however, that instrumentation alone will not tell us as much about the moon, or the planets, as man himself will be able to report once he has visited those distant places. Man contributes observational, analytical, and decisionmaking ability concerning both expected and

unanticipated problems. He provides a vast flexibility of action for operation, correction, and maintenance of scientific and technological instrumentation and equipment that characterize his present usefulness in airplanes and in the scientific laboratory.

In order to provide the capability for the manned exploration of space, a progressive program of research and development has been undertaken. A broad range of investigations, directed to the solution of basic technological problems concerning vehicular configurations and construction, human factors, life-support equipment and accommodations, launching systems, stabilization and control, reentry and recovery systems and techniques, operational and scientific instrumentation, and other vehicular subsystems, is underway. These investigations are presently directed toward solution of the problems associated with the Nation's first manned venture into orbit—Project MERCURY. On the basis of extensive studies, it was determined that Project MERCURY should be based on the use of an ICBM booster launching system and on a ballistic type of reentry into the atmosphere. The use of ballistic reentry offers the best potentiality for early success because of the relative simplicity and reliability of this approach. However, ballistic reentry pays for its simplicity with landing point dispersions that will be operationally and economically unacceptable for extended use. As Project MERCURY nears completion, extensive studies and configuration tests in wind tunnels and free flight will be undertaken as part of a program to develop the capability for landing point control.

A crucial part of the system for attaining landing point control is the stabilization and control system. It is important that this system be capable of both manual and automatic operation, in order to enhance reliability through human backup and in order to allow for the use of onboard human judgment to vary the landing site choice. A comprehensive study, including flight simulators for pilot training, will be required to provide this capability.

In order to meet the foremost objective of Project MERCURY—the attainment of manned orbital flight at the earliest practicable date—additional funds in the amount of $12,200,000 are required prior to the start of the fiscal year 1961.

The additional $12,200,000 is required to pay for contractor overruns, changes in capsule design and construction, and for added capsule requirements. The design changes and added requirements have arisen as a result of development tests and a continuing analysis of safety requirements. The compressed time phasing of Project MERCURY between inception and scheduled flight has required that research, development, design, and fabrication be undertaken simultaneously. Under these conditions, experience has required that modifications to design, arrangement, and structure, be made during the conduct of the program. Efforts to make the Project MERCURY system as safe as humanly possible have inevitably added to the cost, as detailed analyses have uncovered new schemes for enhancing the safety and reliability of the system.

The inability to fund these changes during the fiscal year 1960 will result in a serious slowdown of the capsule program prior to the availability of the fiscal year 1961 funds. The overall cost of the program will not be reduced by deferring the funding of the supplemental requirements.

3. Program phasing

During the fiscal year 1959, much of the preflight research and development effort for Project MERCURY was accomplished and contracts were let for major components of the system. Specifications for the worldwide radio tracking network were prepared and sent out to prospective contractors.

During the fiscal year 1960, the major part of the MERCURY preflight and flight development program will be completed, and component qualification and astronaut training flights will be initiated. The tracking network will near completion during this period.

During the fiscal year 1961, it is anticipated that the MERCURY qualification programs will be essentially completed and that the tracking network will become operational. Large expenditures for the recovery operations and for the operation of the tracking network will be added to flight hardware purchases.

Systems for achieving landing point control will also be under study during the fiscal year 1961. In this connection, two major problem areas require immediate attention: the use of lift to reduce the landing area, and guidance and control methods for piloted landings. Extensive analyses will be made, and scale models of controllable reentry vehicles will be evaluated in wind tunnels. Flight simulators will be used to evaluate the pilot's capability to fly such vehicles.

4. Program costs

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1960 supplemental	Fiscal year 1961
Advanced technical development:				
Biological and human engineering studies	$170,000	$2,180,000		$2,090,000
MERCURY development program	3,100,000	5,270,000		4,050,000
Advanced reentry configuration				800,000
Manual and automatic guidance and control systems for advanced reentry configuration		100,000		200,000
Flight research program:				
ATLAS and REDSTONE boosters	20,840,000	23,460,000		25,650,000
MERCURY capsules, support equipment, and support services	22,299,333	35,012,000	12,200,000	35,290,000
Tracking network operations and equipment	7,000	5,410,000		24,670,000
Recovery operations		3,530,000		15,000,000
Total	46,416,333	74,962,000	12,200,000	107,750,000

Mr. THOMAS. I note this language:

The additional $12.2 million is required to pay for contractor overruns; changes in capsule design and construction, and for added capsule requirements. The design changes and added requirements have arisen as a result of development tests and a continuing analysis of safety requirements.

How much has been spent, say, from January to date on training of your astronauts, and what is the total figure appropriated for 1960 on Project MERCURY? Was it $68,200,000? Was that the total figure? It is in the record. I have forgotten it, but I think it is $68.2 million. What is it?

Mr. ULMER. The amount of the "Research and development" appropriation—the appropriation you are talking about now, Mr. Thomas—the current amount is $74.96 million.

Mr. THOMAS. Is this $12.2 million in addition to that?

Mr. ULMER. You are correct.

Mr. THOMAS. Getting back to my original question, is this $12.2 million for salaries and expenses, or equipment, or both, or is it purely contractor overruns?

Dr. GLENNAN. Do you want an answer to that now?

Mr. THOMAS. Yes.

Dr. GLENNAN. There is none for salaries and expenses.

Dr. SILVERSTEIN. None for salaries and expenses. This is all for continuation of research and development—the contractual effort.

Mr. THOMAS. And it is contract overruns?

Dr. SILVERSTEIN. Some of it is contractor's overruns, and some is associated with changes to things that have been made, and to take into account new things that have been discovered during the process of the development work.

Mr. THOMAS. There is a table over here showing a breakdown of the $12.2 million. It is in one of your green sheets.

Mr. ULMER. It is on page 6.

Mr. THOMAS. You have a better breakdown than that, do you not? What will the $8 million be used for.

Mr. ULMER. For the contracts that Mr. Low and Dr. Silverstein mentioned. For contracts with the McDonnell Aircraft Corp. for making changes in the capsule, for example.

Mr. THOMAS. Does all of this go to the McDonnell Corp. in St. Louis—the entire $12 million?

Mr. ULMER. I think a big part of it does.

Mr. THOMAS. You have supplies and materials in the amount of $1 million, and equipment in the amount of $3 million.

Are they contractual items, or will that come out of your salaries and expenses?

Mr. ULMER. This is a breakdown of what proportion of the $12 million we would buy as services and what proportion we would buy as equipment. It is all R. & D. money; none of it will be used for salaries and expenses.

Mr. THOMAS. This entire amount of $75 million, plus $12 million, goes to McDonnell for Project MERCURY?

Mr. ULMER. Not the entire $75 million. The $75 million covers all R. & D. phases of the MERCURY project.

Mr. THOMAS. What is your total contract with the McDonnell Aircraft Corp.?

Mr. ULMER. There is a line item on page 12 called MERCURY capsules, support equipment, and support services; this item is essentially the McDonnell contract.

Mr. THOMAS. I have it underlined. You have for the ATLAS and REDSTONE boosters $23,460,000 for fiscal year 1960, and you are requesting for fiscal year 1961, $25,650,000.

For MERCURY capsules, support equipment, and support services for 1960, $35,012,000, and the fiscal year 1960 supplemental is $12.2 million.

Dr. DRYDEN. All of that line item goes to McDonnell.

Mr. THOMAS. The entire $12.2 million?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. Well, with this $75 million, plus this $12.2 million, will this get you in shape for a firing of this MERCURY project or will you require some money in your 1961 budget to continue your research?

Dr. DRYDEN. Fiscal year 1961 is in the same table, Mr. Chairman.

Dr. GLENNAN. It is the $35 million which appears there.

Mr. THOMAS. Will that be additional?

Mr. ULMER. Yes, sir; the entire $107 million will be additional.

Mr. THOMAS. Will it be ready to fire, then?

Dr. GLENNAN. We expect so.

(Discussion off the record.)

Construction and Equipment

Program and financing

	Presently available	Revised estimate	Difference
Program by activities:			
1. Aeronautical and space research facilities:			
(a) Langley Research Center	$9,291,727	$9,291,727	
(b) Ames Research Center	4,669,241	4,669,241	
(c) Lewis Research Center	8,636,491	8,636,491	
(d) Flight Research Center	350,000	350,000	
2. Space flight development and operations facilities:			
(a) Goddard Space Flight Center	4,000,168	4,000,168	
(b) Wallops Station	4,878,613	4,878,613	
(c) Jet Propulsion Laboratory	1,955,000	1,955,000	
(d) NASA Huntsville facility	169,101	169,101	
(e) Atlantic Missile Range	7,235,197	7,485,197	+$250,000
(f) Pacific Missile Range	460,000	460,000	
(g) Various locations:			
Tracking facilities	16,424,729	17,174,729	+750,000
Propulsion development facilities	3,450,000	3,450,000	
Total program costs	61,520,267	62,520,267	+1,000,000
3. Relation of costs to obligations: Obligations incurred for costs of other years, net	43,512,798	53,312,798	+9,800,000
Total program (obligations)	105,033,065	115,833,065	+10,800,000
Financing:			
Comparative transfer from (−) Department of Defense	−6,864,298	−6,864,298	
Unobligated balance brought forward	−39,413,540	−39,413,540	
Unobligated balance carried forward	30,069,773	30,069,773	
New obligational authority	88,825,000	99,625,000	+10,800,000
New obligational authority:			
Appropriation	73,825,000	73,825,000	
Transferred from "Research and development" (Public Law 86-213)	15,000,000	15,000,000	
Proposed supplemental appropriation		10,800,000	+10,800,000

Object classification

		Presently available	Revised estimate	Difference
	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION			
09	Equipment	$25,000,000	$33,000,000	+$8,000,000
10	Lands and structures	79,440,445	82,440,445	+3,000,000
	Total, National Aeronautics and Space Administration	104,440,445	115,440,445	+11,000,000
	ALLOCATION TO BUREAU OF PUBLIC ROADS, DEPARTMENT OF COMMERCE			
07	Other contractual services	11,620	11,620	
10	Lands and structures	581,000	581,000	
	Total, Department of Commerce	592,620	592,620	
	Total obligations	105,033,065	116,033,065	+11,000,000

Mr. THOMAS. Let us go to your construction program. Your construction program is in the amount of $10.8 million. You have a breakdown here of it; $4 million is for modifying a launch pad at the Atlantic Missile Range, and $6.8 million is for the MERCURY net tracking facilities.

Is this $10.8 million for contractor overruns?

Dr. SILVERSTEIN. This is for increased requirements from the contractor.

Mr. ULMER. $6.8 million of it is, but $4 million is for an additional project for modernizing a launch pad.

Mr. THOMAS. $4 million is for a new item?

Mr. ULMER. Yes, sir.

Mr. THOMAS. That is for the modification of one of your pads?

Mr. ULMER. Yes, sir.

Mr. THOMAS. In large and round figures, you have about $7 million contractor overruns and about $25,000 each for alterations on your 13 stations, and so forth, plus other items?

Dr. SILVERSTEIN. Additions to the contract. Those additions, I think, are spelled out on page 23 of the justifications.

ATLANTIC MISSILE RANGE

Mr. THOMAS. Let us insert at this point in the record pages 19 and 20 of the justifications.

(The pages referred to follow:)

MODIFICATIONS TO LAUNCH PAD

1. Description

It is proposed to modify and equip existing launch pad No. 12 at the Atlantic Missile Range to launch the ATLAS-AGENA B vehicle. Modifications include providing an umbilical tower high enough to service the AGENA B upper stage, repositioning working platforms in the service tower to conform to the configuration of the ATLAS-AGENA B, and making necessary changes to the ramp to facilitate loading the AGENA B stage on top of the ATLAS booster.

In addition to modifying the pad itself this project provides for the procurement, installation, and activation of checkout, ground servicing, and launch control equipment and instrumentation.

2. Justification

In order to minimize the number of different multistage vehicles in the national inventory, the NASA recently canceled the VEGA program. The missions planned for the VEGA vehicle at the Atlantic Missile Range will be assigned to the ATLAS-AGENA B, an ATLAS-based vehicle of performance approximately equal to that of the VEGA.

The Air Force has recently been able to arrange their ATLAS launch schedule to permit the NASA the use of ATLAS pad No. 12 for launching the AGENA B. However, the facility modifications and the ground support equipment mentioned above are necessary to adapt pad No. 12 to the needs of ATLAS-AGENA B. All conceivable alternative solutions to the problem of providing an AGENA B launch capability at the Atlantic Missile Range were investigated, and the use of pad No. 12 was determined to be the least expensive means of obtaining a suitable pad on time. The leadtimes are such that funds are required promptly if the initial launch date of May 1961 is to be met.

3. Cost estimate

Modifications to pad No. 12	$600,000
Ground handling equipment	900,000
Assembly building equipment	1,300,000
Launch control equipment	1,200,000
Total estimated cost	4,000,000

4. Construction schedule

	Months
Total estimated completion time	12

Mr. THOMAS. This gives us a breakdown of your Cape Canaveral launching alteration.

Is that your final figure? Did you send in a different justification?

Mr. ULMER. The justification differs in that we wish to modify an existing stand rather than build a new stand.

Mr. THOMAS. Your original justification estimated about a 17-month construction period. So, you will not be ready to go until that is completed?

Dr. GLENNAN. That is right.

Mr. ULMER. Actually, under the revised justification the figure becomes 12 months.

MERCURY NET CONSTRUCTION

Mr. THOMAS. The detailed plans for the use of the Navy's Pacific Missile Range station at Point Arguello, Calif., and Kauai, Hawaii, were recently completed. It will be necessary for NASA to provide certain funds for site preparation and new roads, and for utilities such as power, fuel, communications, sewage and water at these sites.

The Navy has been using these. Why is it necessary for you to go in there and establish new facilities such as these?

Dr. DRYDEN. The Navy policy is that the user of a new stand or new site or new facility must provide these utilities. This is also true at the Atlantic Missile Range.

COST ESTIMATES

Mr. THOMAS. We will insert at this point in the record pages 23 and 24 of the justifications.

(The pages referred to follow:)

2. Cost estimate

	Fiscal year 1959	Fiscal year 1960	Fiscal year 1960 supplemental	Fiscal year 1961
Station development and construction:				
Initial site development		$2,700,000		
Station construction			$2,245,000	$2,400,000
Power generators and equipment shelters		1,900,000	690,000	
Ship modifications		2,000,000		
Tracking and data acquisition equipment:				
Procurement of long leadtime radar equipment	$2,425,000			
Precision radar systems		1,750,000		
Accessory equipment for radars		5,000,000		
Precision radar support equipment		2,500,090	590,000	
Active acquisition aids		1,900,000		
S-band radar equipment			250,000	400,000
Seaborne radar and stabilization equipment				1,200,000
Radar accessory and modification equipment				500,000
Data processing and handling equipment:				
Digital data handling and telemetry equipment		1,500,000		
Command transmitter and vehicle communications equipment		1,345,000		
Telemetry recording and data handling equipment		2,000,000		
Data transmission equipment		3,300,000		
Communications and computer equipment		3,100,000		
Extension and improvement of ground communications equipment				1,500,000
Vehicle to earth communications equipment				1,000,000
Telemetry and radar data processing and display equipment			1,425,000	2,800,000
Demonstration, test, and operational checkout equipment:				
Test and checkout of station equipment				3,000,000
Special test equipment			1,800,000	2,200,000
Total estimated cost	2,425,000	28,995,000	7,000,000	15,000,000

Mr. THOMAS. These pages cover your MERCURY station development.

Is this $2.4 million for the modifications down at Cape Canaveral, or is this a part of your Point Arguello modifications?

Dr. SILVERSTEIN. The figure is $2,245,000. It includes increases in the cost of network construction at various sites, the construction of the Arguello Station, and the Kauai Station.

Mr. THOMAS. How much is Arguello going to cost you?

Dr. SILVERSTEIN. $285,000.

Mr. THOMAS. What is the one in Hawaii going to cost you?

Dr. SILVERSTEIN. $610,000.

Mr. THOMAS. Then, you will spend about $25,000 on 13 of your tracking stations?

Dr. SILVERSTEIN. Approximately.

Mr. THOMAS. Is that the way you arrived at your figure of $2,245,000?

Dr. SILVERSTEIN. We have a more detailed breakdown of this.

Mr. THOMAS. Where is it?

Dr. SILVERSTEIN. I can give you some information on it. It is not in the justifications, but I have it.

Mr. THOMAS. Read it into the record.

Dr. SILVERSTEIN. The increases are due partly to increase in engineering construction, staff work, and overtime work involved in constructing the various stations in the net. This is based on estimates of the contractor who shows that in order to complete——

Mr. THOMAS. How many stations are in the net? How many stations are there?

Dr. SILVERSTEIN. There are 18 stations in the net distributed throughout the United States.

Mr. THOMAS. You are not going to modify them? I think I remember a figure of about $25,000 per station for changes to about 12 of them; is that correct?

Dr. SILVERSTEIN. That is correct.

Mr. THOMAS. How many people do you have manning them?

Dr. SILVERSTEIN. It is estimated that there will be about 500 people largely contractor's employees manning these stations outside of those at Canaveral.

Mr. THOMAS. And, a part of their salaries is in this $2,245,000?

Dr. SILVERSTEIN. There are no salaries in this part of the budget.

Mr. THOMAS. You mentioned a while ago that there was some overtime.

Dr. SILVERSTEIN. This is for contractor overtime. There are no S. & E. salaries.

Mr. THOMAS. The salaries for your 500 people at 18 stations are not charged to your research and development program, but they are under S. & E.?

Dr. SILVERSTEIN. Most of the 500 people will be employees of contractors whose services we will obtain under contract using R. & D. funds. The portion of the 500 who will be NASA employees will, of course, be paid from our S. & E. appropriation. What we are talking about here is a construction item, and our construction contractor, in order to meet his schedule, has to put his people on overtime.

Mr. THOMAS. This is purely for contractual items including salaries for contractor's employees.

Dr. SILVERSTEIN. That is right.

Mr. THOMAS. As well as material and equipment?

Dr. SILVERSTEIN. That is right.

Mr. THOMAS. Tracking and data acquisition systems is next. Precision radar equipment shows $590,000; S-band radar equipment $250,000; power generators and equipment shelters, $690,000; and telemetry equipment, $1,425,000. You also have special test equipment for $1.8 million.

Will these all be procured by contract?

Dr. SILVERSTEIN. Yes, sir.

CONTRACTOR'S FEES

Mr. THOMAS. What will be the nature of the contract?

Dr. SILVERSTEIN. Cost-plus-fixed-fee contracts. The Western Electric Co. is our contractor on this net.

Mr. THOMAS. Are they the general contractors?

Dr. SILVERSTEIN. They have associated contractors with them but they are the general contractors.

Mr. THOMAS. How is the fee arrived at? The more they spend the more the fee or the less they spend the more the fee?

Dr. SILVERSTEIN. No, the fee is fixed.

Mr. THOMAS. Is the fee tied directly to the amount of money they spend?

Dr. SILVERSTEIN. No, the fee is a negotiated amount fixed at the time the negotiated estimated cost of the contract is agreed upon. There is no additional fee associated with overruns of the contract.

Dr. DRYDEN. As the scope of the contract changes you might have to renegotiate a fee but it is not based on a percentage of the cost directly.

Dr. SILVERSTEIN. That is a correct statement.

Mr. THOMAS. Are these items subcontracted out by the general contractor, or what?

Dr. SILVERSTEIN. There are major subcontractors to the prime contractor. One subcontractor may be hired for the construction work, one for some of the electrical support work, telemetry, and so forth.

MODIFICATION TO LAUNCH PAD

Mr. THOMAS. Let us get back to the Cape Canaveral project, $4 million.

The new pad will become part of pad 36. Are you going to build a new pad or modernize one?

Colonel HEATON. We will modify an existing ATLAS I stand and we will have to provide a set of complete ground support equipment for that pad.

Mr. THOMAS. How many pads are there in Canaveral?

Colonel HEATON. Of the ones we are concerned with here there are presently four, and one under construction making five. That will be the total.

Mr. THOMAS. Are they necessary? Is it necessary to develop a new pad for this project?

Colonel HEATON. This is modification of an existing ATLAS launch pad that the Air Force recently determined they can spare for our use.

Mr. THOMAS. You either have to modify it or build a new one?

Colonel HEATON. That is right. We have been in continuous negotiation with the Air Force now ever since——

Mr. THOMAS. If you had to build a new one what would it cost you approximately?

Colonel HEATON. Construction itself of the basic steel and concrete portion would have been approximately $2.4 million. However, we have had to add support equipment to make the bare pad suitable for the launching of ATLAS A and B. The total cost was estimated at $4 million.

Mr. THOMAS. When the new rocket comes in, the CENTAUR, will you be able to use this pad or will you have to build a new one?

Colonel HEATON. There is Pad 36 which is well along in construction today under the ATLAS missile program which will be assigned to the central launch area. We might have between pads 36 and this modified pad No. 12 some flexibility to launch both vehicles.

Mr. THOMAS. How is it your big contractor comes in with these overruns of about $8 million?

Colonel HEATON. This is not an overrun, sir.

Mr. THOMAS. What is it?

Colonel HEATON. A modification of a pad.

STATION DEVELOPMENT AND CONSTRUCTION

Mr. THOMAS. What about the items for the MERCURY network?

Dr. SILVERSTEIN. The items we are discussing on the tracking network are not overruns. They are changes that have occurred in the

program for the tracking since the original contract was first negotiated.

Mr. THOMAS. What is the nature of the change, Dr. Silverstein? Is it new equipment?

Dr. Silverstein. Some is. In this breakdown we have here, as you can see——

Mr. THOMAS. That is not in the justification. You are reading from a separate sheet, are you not?

Dr. SILVERSTEIN. Yes.

Mr. THOMAS. Read it into the record. What is it?

Dr. SILVERSTEIN. The station construction of $2,245,000 consists of three items. One is the network construction increase associated with changes in the stations that have been made since the original contract was discussed.

CHANGES IN CONSTRUCTION AND EQUIPMENT

Mr. THOMAS. Changes in the physical properties?

Dr. SILVERSTEIN. Changes in equipment and some changes in buildings. I think building changes are not the major part but the equipment part is the major part.

Next are changes in the PMR station at Arguello.

Third is the PMR station in Hawaii.

Then there are the generators and equipment shelters adding to $690,000.

Mr. THOMAS. Where will the generators be installed?

Dr. SILVERSTEIN. Arguello and Kauai.

We are also adding to the control center equipment building at Cape Canaveral. When we set about setting up a control center we took over a building at Cape Canaveral and adapted it to our purposes.

Mr. THOMAS. What is the nature of the new construction at Arguello and Hawaii? Stations now are operated and run by the Navy.

Dr. SILVERSTEIN. For example, to get the right view from our radars at Hawaii, both——

Mr. THOMAS. You want to put in a new sewage system in one of those places. What is the cost of that and where is it located? You want to put in power utilities. You want to add facilities at all of these places.

COST OF CHANGE IN RADAR SITES

Dr. SILVERSTEIN. We are putting in radars at new sites. They had been in the flats and we have to relocate them. We are being put back of the current site, some distance up in the foothills. This requires that the site be developed to make it usable.

Mr. THOMAS. With sewage, water, light, and everything else.

Dr. SILVERSTEIN. I have the breakdown of how much is in these different areas if you care to have it.

Mr. THOMAS. How far are these new radar sites going to be located from the existing water and sewage facilities?

Dr. SILVERSTEIN. About 10 to 15 miles back up in the hills. The sewage system in the total item of $285,000, for example, for Arguello, amounts to some $16,000. The fuel system is part of the system needed for the diesel power supply, auxiliary power. It amounts to some $20,000, which is tankage, lines, valves, and so forth.

Foundations for the system amount to $12,000.
Road system additions are $35,000.
Clearing and gradings amount to $9,000.
Electrical distribution system is $22,000.

Mr. THOMAS. What does it add up to, about $125,000?

Dr. SILVERSTEIN. $285,000 at Arguello.

Mr. THOMAS. What about Hawaii?

Dr. SILVERSTEIN. They add up to $610,000 and they include items such as clearing and grading, $42,000; roads, $94,000; foundations, $75,000; fuel system, $32,000; sewage system, $35,000; water system, $39,000; electrical distribution, $78,000, etc.

Mr. THOMAS. Are these improvements made for the use and benefit of the personnel or for the tracking system?

Dr. SILVERSTEIN. I would say they are common requirements.

Mr. THOMAS. You already have these same items located in Hawaii and Arguello.

Dr. SILVERSTEIN. At associated sites but at some distance away. In other words, it is too far for the man who would require the use of the sewage system to visit.

Mr. THOMAS. He wouldn't quite be able to make it. How many people will use the sewage system? How long will they be at the sites? Will it be continuous living or will they be there for 2 or 3 days?

Dr. SILVERSTEIN. The activity, once the site is activated, will be such that these people will be living and working in the area continuously on the maintenance of the equipment and calibration of the equipment.

Mr. THOMAS. Why can't the people go by automobile or some other way? They will not spend over a couple hours at a time there, will they?

Dr. SILVERSTEIN. They will be there constantly. This is a very complex piece of equipment which requires continued maintenance and operational practice.

Mr. THOMAS. Can you build roads there and let them come back 15 or 16 miles? That is not far to travel. By building roads you will save an expenditure of at least a half million dollars.

Dr. SILVERSTEIN. Of these items, for example, we have an item for roads, $94,000. We will have to have the clearing and grading because this is where the buildings go.

Dr. GLENNAN. These are not living quarters.

Dr. SILVERSTEIN. These are requirements for the site. We have to have water there.

Dr. DRYDEN. Do either of these models show this?

Mr. THOMAS. That is why I asked if this was for the benefit of the personnel. If so, they could commute 15 or 20 miles a day.

Dr. SILVERSTEIN. You could say it is largely for the technical equipment. There is very little that is particularly associated with personnel because they will not be living there but working there all the time.

MERCURY TRACKING NETWORK

Dr. GLENNAN. Would it be helpful if Major Hammond is permitted to make a brief discussion?

Mr. THOMAS. Yes. Major, tell us about yourself.

Major HAMMOND. Depends on where you want to start, Mr. Chairman. I served with the Navy during World War II. I was discharged and received my bachelor's degree in electronics after which I entered the Air Force.

Mr. THOMAS. What is your job with NASA?

Major HAMMOND. I am listed as a technical assistant to the Assistant Director for Space Flight Operations, Mr. Buckley. I came to him with a background in range instrumentation beginning back in the early V–2 days. I was project officer on the AEROBEE rockets. I worked as an Air Force officer at White Sands Missile Range as assistant to the Army colonel who was in charge of all range instrumentation.

Mr. THOMAS. What is your educational background? Are you an engineer, a physicist?

Major HAMMOND. Electronics engineering and my master's degree from the University of Michigan is in aeronautical engineering.

Mr. THOMAS. All right, proceed.

Major HAMMOND. Mr. Chairman and members of the committee, my purpose today is to discuss the Mercury tracking network and data acquisition equipment.

First I would like to give you some background information on the general subject of instrumentation.

We in the instrumentation business are faced with four basic and primary missions which constitute four different instrumentation problems to us.

First we have the vertical probe type of vehicle which we launch mainly out of Wallops Island. These are instruments to tell us where the vehicle is and to tell us as much as it can about the experiment.

This data is collected as the vehicle flies and it is recorded for later analysis.

Mr. THOMAS. Is this Dr. Van Allen's field or is it his field to get the package that goes into it?

Dr. GLENNAN. The package that goes into it.

Major HAMMOND. In the earth satellite vehicle class, we have a different problem. Here we have a satellite which stays up for weeks and even years. A combination of its movements with relation to the earth's movements gives this effect as it travels in this wide band around the earth. If we use the same analogy with the vertical probe, this would mean we would have to keep this satellite under surveillance all the time while it is in this band. This is not so. We simply maintain surveillance of a wedge of this entire band.

Of course, with a polar type of orbit this band becomes a shell.

With the manned satellite, which basically is nothing more than a special case of the satellite itself, it will be up, and its total mission successfully accomplished, in 4½ to 5 hours.

This means we do not have the length of time available to us to take these periodic measurements as we can with the basic satellite vehicle.

This constitutes a very major difference between the engineering approach to the collection of data from the satellite as opposed to the collection of data from the manned satellite.

The space probe is not exactly germane to our subject this morning but to round out this subject, the space probe is characterized by

extremely long distance data links. For this purpose you see the huge parabolic-type antennas which come up for a good deal of discussion.

The functions that must be carried out by the ground instruments on each one of these basic missions are as follows: First we must know where the vehicle is in space, and we do this through radar devices, and so on, or with tracking devices.

The term "tracking" sometimes is associated with this entire subject, and this is not so as you see from this chart.

The second function we must take care of is that of knowing what is going on inside of the satellite or the vehicle.

In the case of MERCURY here, there are instruments in the vehicle which sense the temperature inside the capsule, pressures, and life support equipments that are in the capsule.

We must also take careful note of the pilot's condition. This is derived by instruments in the capsule and transmitted to the earth by the process of "telemetering."

The next function is that of giving instructions to the vehicle. This is known as "command control." For example, instructions to initiate recovery is the function of the command control equipment.

Finally the integrating element of all this is that of "central control." From here originate the various instructions to the other stations and this is the place where the computations are made, and the information passed on to the various instruments to tell them where to "look" to take the next bit of data from the capsule.

Addressing ourselves more specifically to MERCURY, let us look at some of the engineering problems we were confronted with in deriving the network as you see it here. The vehicle must be carefully watched by our tracking equipment from its point of launch to its point of ejection. This is to give the information that might give rise to the abort signal if the trajectory is not exactly as planned.

Here is another situation. Between Bermuda and the next tracking station——

Mr. THOMAS. What is the altitude of the cone?

Major HAMMOND. On the order of 120 miles.

Mr. THOMAS. What is the strength of the radar equipment?

Major HAMMOND. The strength of the radar is not the determining factor. It is simply that they have only a limited amount of time to look as the vehicle comes up over the horizon. While the vehicle is in its sight, as it passes overhead, there is very adequate strength to make the contact between the radar and the vehicle.

The distance between the Bermuda station and the Canary Islands station is such that when you consider the horizon problem the vehicle will not be under active surveillance, as the first example, between about 8 minutes and 14 minutes, a gap of some 6 minutes.

These are very narrow beam width devices. They have to be told where to look so they can very accurately place their beam on that vehicle as it comes into their sight.

This means, then, that the tracking information derived from the radars at the cape, the radars at Bermuda, must be acted upon in real time.

The term "real time" deserves a bit of explanation. You are hearing my words now in "real time." However, if I were speaking in some foreign language and had an interpreter this would be "near real time."

With the satellite, these satellites I referred to previously, this does not have to be acted upon in real time at all. There is plenty of time for the tracking devices to take note of where the vehicle is, and this constitutes one of the very basic differences between the Mercury network and, for example, the minitrack network you have heard of.

As these various radars go through their tracking periods, this information, as I pointed out, is sent back to the control station where it is acted upon, and the orbit is constructed in real time.

This information then is sent to the next radar, it is told where to look, and when the vehicle comes within its sphere it can then pick up and derive more tracking information for a further bootstrapping of the overall accuracy.

On the other end of the mission, the recovery, the vehicle has completed its three orbits and the radar in Texas has completed its final track, information is sent to the control center.

Mr. THOMAS. How many of these stations are there, 18 altogether?

Major HAMMOND. Eighteen stations. Each one does not have a radar, however.

You will see here on the chart radars for Eglin, the cape, Bermuda, all on the capsule. They are deriving the tracking information, sending it to the computers, who are then predicting exactly the final path location and the recovery area.

Recovery forces are being brought to bear upon this location that is being derived very accurately from the radar track.

I might point out the telemetering aspects of the MERCURY mission. You will find that all of our stations are equipped to receive telemetering information from the capsule.

Further, each station is equipped to talk with the astronaut as he passes within their zone.

Mr. THOMAS. At what stage is this operation? How will you separate the capsule from the booster?

Major HAMMOND. This was in the previous chart on ejection, sir. It separates at exactly what time, Mr. Low?

Mr. LOW. About 5 minutes after launch.

Mr. THOMAS. It is in orbit, then?

Major HAMMOND. Final injection, yes.

The network itself consists of these stations as shown on the map. The red squares are those stations that were existing military stations, including Australian military stations.

Permanent sites being built as a result of the MERCURY program number only one, the station at Bermuda.

The van-mounted tracking and telemetry sites are, as you see, in the green squares. They are being built on a temporary movable type concept so they can be moved to other locations at the completion of the MERCURY program.

You will note there are several stations in blue. They are simply telemetering locations. They do not have tracking radars.

Mr. THOMAS. Where in Florida?

Major HAMMOND. We will fire from Cape Canaveral. The first orbit goes out slightly under Bermuda, swings up by the Azores. This is the mid-Atlantic ship. Then it goes by this point at Canary Islands, Nigeria, Zanzibar, Indian Ocean ship, Australia, the two points shown, and the Kauai station

Mr. THOMAS. Will it be in orbit when it gets to the first station?

Major HAMMOND. Yes; before it gets to Bermuda.

I would like to point out this model if I may. The two stations, the one at Bermuda and the one at Kano, Nigeria, are to show the two types of stations, one being the most elaborate and the other the most simplified.

The transmitting and the receiving sites are separated because of radio frequency interference problems in both cases.

At Coopers Island, on the tip of the island of Bermuda, the S band radar is there, the C band radar, and the equipment to communicate with the pilot.

At the Town Hill location we have the receiving area. Telemetering signals are received and also the receiving equipment for the communications with the pilot again.

Kano turns out to be a sort of anchor point, for ground communications, because the communication links from Australia and the East Indian Ocean ship will be relayed through the station at Nigeria up into London.

Mr. THOMAS. This capsule will not lose much altitude, will it?

Major HAMMOND. Not in three orbits; no, sir.

You will note the large rhombic antennas at Kano. This is the equipment that relays the ground communication information. It transmits the data in as close to real time as possible from the various stations back up through London, as I pointed out, back to the control center at Cape Canaveral.

Mr. THOMAS. What information are you going to get at the first station as it makes its first orbit compared to that at the last one as it completes its first orbit?

Major HAMMOND. Would you repeat that?

Mr. THOMAS. What information will you get out of the first station which will be different from the information at the last station? Where is the last station?

Major HAMMOND. This station is in Hawaii.

Mr. THOMAS. Is that the last one?

Major HAMMOND. I would not say last, no, sir. The last station turns out to be essentially the same as the first station because of the recovery.

The difference in data is essentially none.

This first station, however, is elaborate because of the injection and abort problems that we have. It is actually no more elaborate than, for example, the cape station when you look at it as a given set of instruments. They have the same radars, for example.

However, the trick here is making all of these radars work together in "real time."

Mr. THOMAS. If you do not get any variation in information that is a sign that everything is going well, is it?

Major HAMMOND. Yes, sir.

Dr. SILVERSTEIN. Other functions should be stressed. At the Bermuda station what we are trying to find out for sure is that this man is in orbit.

If his velocity is off or his angle is a little wrong he will not go into orbit. We want to know if he is not going into orbit where he is coming down so we can have the recovery forces there ready to pick him up.

Dr. DRYDEN. It is better to recover him in the Atlantic rather than many other places.

Mr. THOMAS. After he has made two revolutions he is pretty safe?

Dr. DRYDEN. Yes.

Dr. SILVERSTEIN. We would like to learn something about his psychological response to this weightless condition over that period of time. We want to be in touch with the man. We do not want to leave him up there lonely, not knowing his condition, so we feel it is necessary to maintain communication with him.

Mr. THOMAS. At that altitude you are completely out of the earth's atmosphere, are you not?

Dr. SILVERSTEIN. Basically.

Mr. THOMAS. Will you have any instruments to show you the rate of change in temperature?

Dr. SILVERSTEIN. Yes. The man's ekg will be telemetered to the ground, also respiration, and many other things.

Mr. THOMAS. Spell it out in detail. What information will be radioed back? One is the temperature?

Dr. SILVERSTEIN. Yes.

Mr. THOMAS. What will be the heat going through? What do you expect the temperature to be when he gets up to about 100 miles?

Dr. SILVERSTEIN. We will try to hold the temperature in the cockpit in the range of 70° to 100° F.

Mr. THOMAS. What will the metal on the cone be?

Dr. SILVERSTEIN. Metal on the outside of the body will be of about that same order in/quilibrium coming back in.

Mr. THOMAS. Changes when it is going up, too, is it not

Dr. SILVERSTEIN. Yes.

Mr. THOMAS. What will be the temperature on the outside of the cone fighting the earth's atmosphere for about 80 miles?

Mr. LOW. About 500° to 600° on the way out.

Mr. THOMAS. You must have good insulation so the heat does not get inside the cone.

Dr. SILVERSTEIN. That is right.

Major HAMMOND. I would like to point out at this time several of the representative occurrences that are perhaps apropos to this supplemental request.

As pointed out by Dr. Glennan's statement, there is the necessity to provide these new installations at Kauai and Point Arguello.

Secondly, such simple things as when we try to use the Government-furnished equipment, surplus 584 radars, as they are taken out of storage they cannot immediately be taken by our contractor to convert them into a long-range radar without refurbishing and bringing them up to the condition they were in when they were stored.

Also we have the problem of the available——

Mr. THOMAS. Is this old Navy equipment or brandnew?

Major HAMMOND. Surplus equipment for the S-band radars.

Mr. THOMAS. Short-range?

Major HAMMOND. It was in its original configuration. It is being modified.

Before the modification can proceed the old radar had to be brought up to its original condition. The available buildings at the cape which we are planning to use for our control center require extension and modification. Further, the recovery operations will be under the

cognizance of the Navy and also will require space in that same building.

There is a problem of the distortion range.

When the radar at Bermuda and the radar at the cape are both looking at the capsule——

Mr. THOMAS. Excuse me.

REIMBURSEMENT TO THE NAVY

Dr. Glennan and Dr. Dryden, do you have to reimburse the Navy for this?

Dr. GLENNAN. We will reimburse the Navy for certain costs.

Mr. THOMAS. If they are interested in POLARIS they have to go through the same thing you are except in a little different degree. On one of these shots what will your reimbursement cost be to the Navy?

Dr. GLENNAN. We have a figure on this. Perhaps he can be checking this.

Mr. LOW. Only part of that is connected with the Navy.

I do not have it broken down for each shot. The total will be about $5½ million for all of the ATLAS, REDSTONE, and LITTLE JOE shots through fiscal year 1961.

Mr. THOMAS. How many shots does that cover?

Mr. LOW. Eight REDSTONE shots, nine ATLAS firings, and five LITTLE JOE shots. That is through fiscal year 1961.

Mr. THOMAS. The lion's share will be spent in 1961, then?

Mr. LOW. Yes, sir.

DETERMINATION OF NEEDS FOR FUNDS

Mr. JENSEN. Mr. Chairman, I have been listening very attentively and I am impressed by the knowledge which you have of this whole program; and also I am impressed, of course, by the answers given by Dr. Glennan and his staff.

I can only say that I am trying to get all possible information relative to this program. I have had some previous information. I am a member of the committee which appropriates for the Atomic Energy Commission, and there, also, I have to take the word of the Director for just about everything he wants.

Do you have a sort of "kitchen cabinet," so to speak, which makes all these determinations as to what you feel is needed in the way of appropriations when requests are made by your different officials and heads of different divisions? You have such a staff, do you not?

Dr. GLENNAN. Yes, sir. It is quite a process, Mr. Jensen.

In the first instance the Associate Administrator, Mr. Horner, calls together the laboratory directors, such as Dr. Pickering, Dr. von Braun, and others, to discuss the general nature of the program, the number of shots, the types of experiments we will undertake.

This information is then funneled out to the laboratories as program guidance and they send back in sometime in perhaps June, as I recall it, their first cut at the budget. This is usually perhaps twice what we ultimately deal with here because they are always ambitious, as you know.

Then the headquarters staff in each of these areas, such as in Dr. Silverstein's area and in General Ostrander's area, will take that budget and work on it to see what water there may be in it, what elements ought to be questioned.

This is finally taken by these people to a budget review committee. Last year it was under the chairmanship of Mr. Siepert, our Business Administration head. Last year they spent several weeks analyzing all the details of the 1961 budget.

They then report to me and to Dr. Dryden and to Mr. Horner on their analysis of the budget, and the three of us then have a go at it and decide what we think makes sense and send it back out to the field. This gets out at about August 15, at which point the field stations and the separate organizations in headquarters or elsewhere rework their budgets along the guidelines we have given them, and they may quarrel with what we have said. They have a perfect right to come back and argue with us again.

Finished budgets come in about September 1. They get final review in headquarters and are submitted to the Budget Bureau on about September 30.

We are just starting the 1962 process now.

Mr. JENSEN. Supplemental requests from almost every Department of Government are getting out of hand. We will have to insist henceforth, as I am sure Mr. Thomas has notified you a long time ago, that it will be pretty difficult for any agency to get a supplemental unless they can prove a great need or an emergency.

Do you think that this is in the category of a great need or an emergency, Doctor?

Dr. GLENNAN. I do, in this sense, Mr. Jensen: We are in the research and development business, as you know, which is not a clearly predictable business. Changes in requirements occur. Experiments indicate that this or that was not designed as it should have been, and this necessitates additional work and rework.

In the normal course of a research and development program where there are no time scales attached, I think one would not be coming back here to argue for a supplemental, but what we are faced with here is a very high priority. It actually carries a priority identical with that of the ATLAS program, for instance, the highest national priority. We find ourselves in this situation: For instance, if we do not have the means to push forward urgently with this network problem, we probably slip these schedules 3 to 4 months, and the funding for the capsule rearrangements and rework get into the same general ballpark. This is an attempt to keep to a schedule which has slipped as much as we can allow it to slip.

BENEFITS OF THE SPACE PROGRAM

Mr. JENSEN. Just what do you expect to accomplish by the space program and what benefit to the United States of America do you expect if we are able to put a man on the moon or on some other planet? That is the question which the common layman asks.

Mr. THOMAS. You mean that is the $64 question?

Mr. JENSEN. It is. Of course, I am one of the very common laymen in this field of space, as is almost everybody else.

Can you tell us in a few words, and you can elaborate on it for the record if you so desire, what the benefits are which we can accrue from this space program?

Dr. GLENNAN. If we knew exactly what we were going to get here we would not be——

Mr. JENSEN. What is the purpose?

Dr. GLENNAN. We would not be working at it as hard as we are. New knowledge which ultimately should result in a better control of our environment is what we seek.

We expect ultimately to be able to do a better job of weather predicting over a very much longer period of time. It is possible that with that kind of knowledge we may ultimately find a way to modify, not to control, but to modify, weather.

It is probable that within a period of 10 years the kind of communications systems which we presently are designing and building, that is the rather normal conventional cables, radio links, and that sort of thing, will be utterly unable to carry the discussion that goes on between countries that our Defense Department needs in keeping in contact with its farflung outposts.

It is expected that a communications system using satellite based reflectors will make possible around the world television, for instance, and the carrying of very, very heavy traffic between continents and between stations in our military and civil networks.

It is of interest to note that in some ways part of the work we are doing is similar to that which was done by the Navy very recently when they transmitted a message and a picture via the moon from Washington to Hawaii.

We will later this year be putting up some artificial moons, if you will, the 100-foot balloons with which we have been experimenting off Wallops Island. We expect to put some of those into orbit during the course of the year and that is simply bringing the moon under control so we will have it where we want it when we want it.

Beyond that, Mr. Jensen, the search for new knowledge is a matter about which we must be constantly on the alert and which we must pursue aggressively.

This Nation has grown to its present position of prestige and power largely through the application of new scientific knowledge which has been found out both in this country and other countries. The leadership in this field cannot be allowed to pass from our hands, and this space field provides us perhaps the most difficult and perhaps the most expensive area in which to seek new knowledge, and yet there is knowledge to be had there that we can get in no other way.

As in most research and development programs undertaken by governmental agencies in support of wartime activities, the fallout, if you will, from these programs in terms of new processes and new techniques, finds its way back into industry constantly. The electronics industry is a result largely of the war requirements for radar and communications equipment and the tremendous expansion in all of those highly specialized industries based on advanced technology. They come from the kind of support that the Government provides in times of stress or in programs of great urgency of this kind.

Perhaps Dr. Dryden would like to add to that.

Dr. DRYDEN. There are only two additional remarks I would make. They have to do more with the rate at which we do the work, perhaps, rather than the fact we are as a Nation compelled to work in the space field. One of these is the matter of our competition to which Dr. Glennan referred. Much to the surprise of many of us, the fact that

the Russians did secure some spectacular firsts in this field has had a very great effect on the reaction of other people of the world to our whole social system. We can argue they should not, that this is not significant, but it is a fact which is attested to by the head of the USIA. There is a need to be strong in this field and it is very essential to our posture before all the nations of the world and the way in which they regard us and our social system.

Finally, although we do not now see clearly as sensible and reasonable men exactly what kinds of weapons will come out of the space field, we do not know of any developments in technology which have not found application in our national defense system. There are certain areas which we see now, such as reconnaissance satellite, but I think our vision of what actually can come forward is about as cloudy as at the time of the first airplane when men found it difficult to see what this new element would mean in the military field.

I think if we put this together with the economic benefits, benefits to industry, and so on, as described by Dr. Glennan, that we have the case for the necessity for this country to go forward with the exploration of space and all that it implies just as rapidly as makes good sense from the technological point of view.

Mr. JENSEN. Russia, of course, was in this field many years before we were, so far as the satellite program is concerned. They launched the first satellite, sputnik. How many years were they operating in this field before we got started?

Dr. GLENNAN. The launching of satellites or deep space probes is based on the use of a rocket system, and it is our estimate that they have been in the business of developing their rocket systems initially to carry nuclear warheads and later to carry space satellites and probes for, perhaps, 4 to 5 years longer than we have been. We started our really significant work in the missile business in 1954—late 1953, 1954, and 1955. The Russians paid particular attention to the space business, the significant date being the date when they set up a council—I have forgotten the exact name——

Dr. DRYDEN. Commission on Interplanetary Communications.

Dr. GLENNAN. They set up the CIC in 1954. This would have been the equivalent of NASA being set up in 1958.

Mr. JENSEN. Well, then, they had a 4-year lead on us?

Dr. GLENNAN. Yes, sir; in the planning of their program.

COMPARISON BETWEEN UNITED STATES AND SOVIET SPACE PROGRAM RESULTS

Mr. JENSEN. I wish you would state for the record your opinion as to a comparison between our space programs of this date and the Communist space program, as much as you feel you could say without divulging any of our secrets.

Dr. GLENNAN. All right, sir.

Mr. JENSEN. Will you do that?

Dr. GLENNAN. I will provide that for the record. I will submit a report prepared as of December 15, 1959, by Dr. Newell which provides the information you are requesting.

(The information follows:)

United States and U.S.S.R. Space Science Results

Homer E. Newell, Jr., Assistant Director, Space Sciences, National Aeronautics and Space Administration

RESULTS OBTAINED

The United States has been using sounding rockets for upper air research and rocket astronomy since the close of World War II. WAC CORPORAL, V–2, VIKING, AEROBEE, AEROBEE-HI, NIKE-DEACON, NIKE-CAJUN, NIKE-ASP, and ROCKOONS were used. Altitudes attained were below 200 miles for the most part. Many hundreds of rockets were fired prior to the start of the International Geophysical Year; an additional 200 were fired as part of the International Geophysical Year program. Current rate of rocket soundings is somewhat below 100 per year. Higher altitude rockets are being introduced into the work to extend the atmospheric observations to one to several thousands of miles altitude. Launchings have been carried out at White Sands, N. Mex.; Wallops Island, Va.; San Nicolas Island, Calif.; Cape Canaveral, Fla.; Fort Churchill, Canada; Guam; and from shipboard in the North Atlantic, the mid- and South Pacific, and the vicinity of Antarctica.

The U.S. program has produced hundreds of research papers and reports giving results on the pressure, temperature, density, winds, and composition of the upper atmosphere, the ionosphere; the earth's magnetic field; the aurora and airglow; cosmic rays; micrometeors; solar radiations; and ultraviolet astronomy. Some experiments have been carried out on modifying the upper atmosphere by the release of special chemicals, and on modifying the radiation belt by nuclear explosions. Some biosciences experiments have been performed.

The U.S.S.R. has also been carrying out a rocket-sounding program since the last war. Although the precise number of rocket soundings to date is not known, they number in the hundreds. Firings have been made from Franz Josef Land and from Mirny in Antarctica, as well as from European U.S.S.R. The Soviets have perfected a meteorological sounding rocket that is used for more or less routine soundings of the atmosphere to measure air pressures, densities, and temperatures up to 35 miles altitude. In addition, their "geophysical rocket" is capable of carrying ton-and-a-half payloads up to 300-mile altitudes.

From their sounding rocket program the U.S.S.R. has obtained a broad collection of results. The meteorological soundings have produced detailed data on the structure of the upper atmosphere just above the troposphere, showing its temporal and seasonal variations. The geophysical rocket program has provided considerable information on the very high atmosphere, including the ionosphere. The description of one of the geophysical rocket payloads is so similar to the description of Sputnik III and its instrumentation as to lead one to conjecture that the payload may have been essentially the Sputnik III payload. Whether or not this is the case, the instrumentation provided for a broad range of measurements on the ionosphere, atmospheric structure, energetic particles, and the earth's magnetic field. The U.S.S.R. rocket program has also included considerable work on biological researches. There have been some 20 tests in which dogs, and/or rabbits were sent aloft and recovered for study. During the flight the behavior of the animals was telemetered to ground.

The U.S.S.R. launched the first successful artificial earth satellite. To date the U.S.S.R. has successfully launched three earth satellites and three space probes. Two of the space probes achieved earth escape velocity; the first passed within two or three moon diameters of the moon. The second Soviet space probe actually hit the moon. The third space probe was launched so as to pass close enough to the moon to take pictures of the unseen side of the moon's surface, then to loop around the moon returning to the earth. The lunar pictures were successfully obtained.

The United States has to date successfully launched 15 earth satellites; namely 5 Explorers, 3 Vanguard, 1 Project Score, and 6 Discoverers; and 3 space probes, all called Pioneers. Only one of the space probes achieved earth escape velocity, passing by the moon at some 37,000 miles distance.

Both the United States and Soviet satellites and space probes have produced valuable scientific results. Included are some spectacular discoveries and achievements, some of which are given in the accompanying table No. 1. In addition to the more spectacular output, these satellite and space probe flights are turning out a steady flow of information and results that build up gradually to an impressive advancement of mankind's knowledge of the earth and outer space. Some of these are listed in table 2.

PROBLEMS BEING ATTACKED

In attempting to compare the relative stages of advancement of the United States and the U.S.S.R. in space research, one might proceed by trying to list item by item the individual results from the two programs and to relate these results item to item. This would turn out to be difficult even if one were sure that all the results obtained by the Soviets were actually at hand, for there would be many observations obtained by the Russians that had not yet been obtained by the United States, and conversely, many obtained by the United States that had not yet been obtained by the Russians. A more effective, and perhaps more significant way of comparing the relative stages of advancement, would be to isolate the general areas of investigation and the general problems being attacked by the two countries.

Taking this approach one can say that the United States and the U.S.S.R. appear to be at about the same stage of advancement in upper air research. The U.S. results on the atmosphere below 200 miles appear to be more detailed and complete, but the Soviets have made higher altitude measurements by means of their geophysical rocket. The Soviets appear to have done far less than the United States on solar radiations, but the U.S.S.R. has done much more than the United States on biosciences experiments, having conducted numerous flight tests in which dogs were carried aloft in rockets and safely recovered. The U.S.S.R. has carried the technique of ejecting instrumented packages from the rocket carrier farther than has the United States, which has carried the technique of telemetering to a high degree of refinement.

Likewise, the United States and the U.S.S.R. seem to be at about the same stage of advancement in studies of the earth's environs where satellite techniques are adequate for making the necessary observations. In fact, it may be that in this regard the United States has the slight edge. The big advantage the Soviets have in attacking these problems lies in their greater payload capacity. On the other hand, the United States has launched many more satellites than the Soviet Union.

In deep space probe work the U.S.S.R. has definitely taken the lead. This is directly attributable to their clear lead in vehicle technology.

Table 3 provides a comparison of the states of advancement of the United States and the U.S.S.R.

A review of table 3 shows fairly clearly that the United States and the U.S.S.R. scientists are at about equal stages of advancement in the problems they are attacking or are about to attack in space research. As groups they undoubtedly have comparable competencies and understandings of the significant problems that ought to be tackled. Their instrumentations are roughly equivalent, although the United States may have a slight edge here, as indicated by the fact that the U.S.S.R. quite often simply copies U.S. equipment for its own instrumentation. The conclusion follows then that the side that has the more advanced technology in the way of payload capabilities, guidance, etc., will have the distinct edge and, by virtue of the increased flexibility and capabilities provided by the more advanced technology, will forge steadily ahead. Thus, one may predict a time lead in vehicle technology will be transformed into a corresponding time lead in the exploration and investigation of outer space.

TABLE 1

SIGNIFICANT FIRSTS IN SOUNDING ROCKET, SATELLITE, AND SPACE PROBE RESEARCH

UNITED STATES

1. A number of firsts in high altitude rocket research, including among others:
   - First detailed photo of solar ultraviolet spectrum.
   - First photo of complete tropical storm.
   - First penetration of equatorical ionospheric current sheets.
   - First detection of X-rays in high atmosphere.
   - First detection of auroral particles in high atmosphere.
2. Discovery of the Van Allen Radiation Belt.
3. Discovery that the Van Allen Radiation Belt consists of at least two zones.
4. Performance of the Argus experiments.
5. The first precise geodetic use of artificial earth satellites (Vanguard I) to obtain refined information on the size and shape of the earth, providing an improved value for the flattening and showing that the earth is actually slightly pear shaped.
6. First achievement of an elementary communication satellite, in Score.

U.S.S.R.

1. First artificial earth satellite.
2. First lunar near miss.
3. First lunar impact.
4. First pictures of the hitherto unseen side of the moon.
5. First detection of what may be a current ring about the earth (the Chapman-Stormer ring).
6. First routine recovery of large animals (dogs and rabbits) from high altitude rocket flights.
7. Development and routine use of a meteorological sounding rocket, recoverable and reflyable.
8. First launching of a large animal (Laika) in a satellite of the earth.
9. First high capacity, maneuverable, heavily instrumented, space-craft with fully successful long-range communication (Lunik III).

TABLE 2.—*Sounding rocket, satellite, and space probe results*

Field	United States	U.S.S.R.
Upper atmosphere	1. Rocket observations have been made of pressure, temperature, density, composition, and winds of the high atmosphere at a wide variety of locations, both day and night, and in the various seasons.	1. Rocket observations have been made of pressure, temperature, density, composition, and winds of the high atmosphere at a wide variety of locations, both day and night, and in the various seasons.
	2. Upper air densities have been obtained from the tracking of both U.S. and U.S.S.R. satellites.	2. Upper air densities in the higher latitude regions obtained from drags on Sputniks I and III.
	3. It has been shown that the radiation belt may account for much higher atmospheric temperatures observed in the auroral zone atmosphere than in the high atmosphere above the middle and equatorial regions.	3. High enough flux of low energy electrons measured with Sputnik III instruments in the northern regions to account for the higher atmospheric temperatures there.
	4.	4. Direct measurement of upper air densities made with gages in Sputnik III, for heights up to 355 kilometers.
	5. Fluctuation in satellite drag, hence presumably upper air densities, have been shown, from observations on Vanguard I and Sputnik II, to be directly correlated with fluctuations in the 10 centimeters radiation from the sun, and hence solar activity.	5.
	6.	6. The routine meteorological sounding rocket has been used to give atmospheric structure data at middle-European, Arctic, and Antarctic locations showing seasonal variations as well as geographic. It turns out that the seasonal variations are different for the different altitude ranges.
	7. From both satellite and rocket observations high altitude air densities have been shown to vary widely with time of day, season, and geographic position.	7.
	8. The amounts of diffusive separation both below and above the E region of the ionosphere have been measured in sounding rocket experiments, and shown to be very slight below the E region and quite pronounced above altitudes of 110 to 120 kilometers.	8. Diffusive separation in the upper atmosphere below the E region has been measured with results that agree in general with the U.S. observations.
Ionosphere	1. Extensive electron density data have been obtained for a number of locations from rocket soundings.	1. From rocket soundings electron densities have been obtained up to and above the F region maximum.
	2. From radio signals of both U.S. and U.S.S.R. satellites, propagation characteristics of the ionosphere and electron density distributions have been obtained.	2. Electron densities above 300 kilometers were obtained by observation of the radio signals of Sputniks I and III.
	3.	3. Observations on Sputnik I showed 3.5 times as many electrons above the F region maximum as below.

TABLE 2.—*Sounding rocket, satellite, and space probe results*—Continued

Field	United States	U.S.S.R.
Ionosphere—Con....	4. The heavy ions in the ionosphere above White Sands and Fort Churchill have been identified up to the F region in rocket sounding experiments.	4. The ionic composition of the ionosphere has been measured in sounding rockets to above the F region maximum.
	5.	5. Sputnik III observations showed that the predominant ion from 250 to 950 kilometers is positive atomic oxygen, O+.
	6.	6. In Sputnik III the satellite potential in the daytime ionosphere was observed to be as much as −7 volts.
	7. Very low frequency propagation data were obtained from Explorer VI.	7.
	8.	8. In the second lunik, evidence of a lunar ionosphere was obtained.
Magnetic field.....	1. Data on earth's magnetic field were obtained from Pioneer I and Explorer VI, and a great deal of additional high quality data are being obtained from Vanguard III.	1. Data on earth's magnetic field obtained from Sputnik III.
	2. By their magnetic effect, electric current flows were plotted in the E and lower F regions, in rocket sounding experiments in the equatorial regions.	2.
	3.	3. On mechta measurements were made of the earth's magnetic field and its extension into space. A marked dip in the field was discovered in the region of the radiation belt, indicating perhaps the existence of a current ring such as postulated by Chapman.
	4. Rocket measurements of the earth's magnetic field have been made in the auroral regions.	4.
	5.	5. Lunik II, on its plunge to the surface of moon, showed that the lunar magnetic field is not greater than 50 gamma.
Cosmic rays.....	1. Extensive data on cosmic ray intensities, composition, and interactions with matter were obtained from sounding rockets in various locations and throughout all the seasons.	1. Cosmic radiation measurements have been made in U.S.S.R. sounding rockets.
	2. The cosmic ray count was obtained above the atmosphere with counters in Explorer satellites and Pioneer probe.	2. The cosmic radiation was measured in Soviet satellites and space probes.
	3. Cosmic ray counts in the first Explorers gave discovery of the radiation belt.	3. Sputnik II observations showed an increase in counting rate with height (this being at the time, an unrecognized hint of the presence of the radiation belt).
	4. Details on the cosmic radiation as a function of time and position in space have been obtained from Explorer VI, and are being obtained from Explorer VII.	4. Sputnik III and cosmic rockets provided measurements on the heavy nuclei in the cosmic radiation.
Radiation belt.....	1. Radiation belt discovered with instruments in Explorer I.	1. Abnormally high cosmic ray counts were observed in Sputnik II, particularly at the high latitudes. Sputnik III showed a very high electron flux in the northern latitudes.
	2. A great amount of additional detail obtained on belt in Explorers III and IV, and the Pioneer probes. Extent of radiation belt shown by Pioneer I. Pioneer III showed belt to consist of at least two zones.	2. Sputnik III, Mechta, and other Soviet satellite and space probe observations confirm the U.S. findings.
	3. Pioneer IV showed the extent of the outer radiation belt to have increased greatly following a 5-day period of high solar activity, thus proving that the outer belt is of solar origin.	3.

TABLE 2.—*Sounding rocket, satellite, and space probe results*—Continued

Field	United States	U.S.S.R.
Radiation belt—Con.	4. Argus experiments showed individual inner zones of the radiation belt to be very stable.	4.
	5. Argus observations lends support to conclusion that inner radiation belt produced by cosmic rays. See No. 7 below.	5.
	6. Detailed energy spectrum of radiation in radiation belt was obtained by Explorer VI.	6.
	7. Sounding rocket observations showed that the energetic particles of the inner radiation belt are protons of energy spectrum expected from β decay of neutrons, hence supports cosmic ray origin for hard components of inner belt.	7.
	8. Extensive additional information on the radiation belt was obtained from Explorer VI and is being obtained from Explorer VII and Vanguard III. Huge variations of many orders of magnitude in counting rates were observed in outer zone.	8.
	9. Radiological hazard of radiation belt estimated to be not serious for a direct traverse of the belt; but quite serious for a space station that spends a lot of time in the belt.	9. Radiological hazard of radiation belt estimated to be not serious for a direct traverse of the belt; but quite serious for a space station that spends a lot of time in the belt.
	10.	10. The moon was shown not to have a radiation belt detectable within the sensitivity of Lunik instruments.
Aurora	1. Rocket soundings have been used to study the electromagnetic and particle radiations in the aurora. It was found that soft radiation flux above 40 kilometers was many times the primary cosmic ray count.	1.
	2.	2. A very high flux of low-energy electrons was observed in Sputniks II and III. This flux was taken to be the cause of the very high atmospheric temperature in these regions.
	3. The particles in the outer radiation belt have been shown to be the likely immediate cause of the aurora.	3. The particles in the outer radiation belt have been shown to be the likely immediate cause of the aurora.
Geodesy	1. Vanguard I observations give an oblateness of the earth of 1/298.3.	1.
	2. Vanguard I observations show the earth to be pear shaped with a 50-foot peak at the North Pole, and a 50-foot flattening at the South Pole; this appears to imply an internal strength to the earth, rather than a free-flowing plasticity.	2.
Meteors	1. A fairly low count of micrometeors corresponding to a total influx of 1,000 to 10,000 tons of material per day, from Explorer and Pioneer observations.	1. Influx of material per day indicated by Sputnik III observations in general agreement with the U.S. results.
	2. A very large amount of additional data are being obtained from the Vanguard III instrumentation.	2. Additional measurements made in Soviet cosmic rocket flights.
Astronomy	1. In sounding rocket experiments ultraviolet sources in the sky have been detected and plotted.	1.
	2. The solar spectrum has been observed and photographed down to 303 angstroms.	2.
	3. Solar radiations have been observed and measured in the X-ray regions.	3.
Lunar explorations	1.	1. First photos taken of the hitherto unseen side of the moon.
	2.	2. The lunar magnetic field shown to be no greater than 50 gamma.
	3.	3. Lunar ionosphere detected.

TABLE 2.—*Sounding rocket, satellite, and space probe results*—Continued

Field	United States	U.S.S.R.
Miscellaneous experiments.	1. The Argus experiments were carried out.	1.
	2. Sodium vapor was released in the high atmosphere and observed to measure its radiations, atmospheric winds, and diffusion.	2. Sodium clouds were released from Luniks II and III and observed from the ground.
	3. Various chemical contaminants were released in the high atmosphere to study the photochemical reactions that resulted.	3.
Biosciences	1. On numerous sounding rocket flights biological specimens of seeds, fruit flies, etc., have been flown and recovered for study. Larger animals, such as rats and monkeys, have been flown for study of their behavior and the effects of the flight environment on them. Recovery of such animals has been effected on numerous occasions.	1. Large numbers of sounding rocket experiments have been carried out with dogs and rabbits, in which the animals were both studied during flight and recovered after flight for further study.
	2.	2. Observations were made on the behavior of Laika, particularly heartbeat and respiration, in Sputnik II.
Engineering data	1. U.S. satellites show that moderate temperatures can be achieved in orbiting vehicle.	1. U.S.S.R. satellites and space probes show that moderate temperatures can be achieved by appropriate engineering.
	2. Elementary communications link checked out in Project Score.	2.
	3. Based on radiation belt data, it is deduced that satellites may charge to a potential of some hundreds of volts in the radiation belt.	3. Sputnik III measurements show that in the daytime ionosphere the satellite acquired an appreciable negative charge corresponding to a negative potential of several volts.
	4. The meteor erosion and puncture problems have been shown in general to be not particularly serious.	4. The meteor erosion problem appears to be not particularly serious.
	5. An elementary TV scanner was checked out in Explorer VI, while some of the basic elements of a meteorological satellite were checked out in Vanguard II.	5.
	6.	6. Automatic photography of the moon and the televising of the photographs obtained back to earth has been achieved.
	7. Solar cells have been shown to be a practical, reliable source of power.	7. Solar cells have been shown to be a practical, reliable source of power.
	8.	8. A complete spacecraft, maneuverable, with temperature control, power supply, long-range communications link, complicated instrumentation, etc., has been engineered and flown successfully; namely, Lunik III.
	9. It appears that the radiological hazard to space vehicle crews traversing the radiation belt directly may be relatively low, while the hazard to those in a satellite orbiting through the radiation belt would be quite serious. In addition, marked increases in proton intensities of the cosmic radiation found at the time of solar activity may be a very serious radiological hazard: dose rates of 1,000 r/hr.	9. It appears that the radiological hazard to space vehicle crews traversing the radiation belt directly may be relatively low, while the hazard to those in a satellite orbiting through the radiation belt would be quite serious.
Meteorology	1. Numerous sounding rocket photos of cloud formations and significant weather areas have been taken. In particular a composite photo from 1 sounding rocket showed a completely developed tropical storm approaching hurricane proportions.	1.
	2.	2. A meteorological sounding rocket was developed and has been used on a routine basis for meteorological studies.

TABLE 2.—*Sounding rocket, satellite, and space probe results*—Continued

Field	United States	U.S.S.R.
Meteorology—Con...	3.	3. Detailed measures of pressures and temperatures have been obtained with the meteorological rocket for Antarctic, Arctic, and Middle European locations.
	4. Cloud picture data were obtained in Vanguard I, but motions of the satellite have so far prevented reducing the data to useful pictures. Also, very low resolution, elementary television pictures have been taken of cloud formations as seen from Explorer VI. One of these pictures was assembled and released.	4.

TABLE 3.—*Problems currently under attack*

Field	United States	U.S.S.R.
Upper atmosphere...	1. A detailed study of the structure, winds, and composition of the ionospheric regions and beyond in the earth's atmosphere is underway by means of sounding rockets and earth's satellites. 2. Work is underway to develop a routine rocket sonde for synoptic studies of the lower portion of the upper atmosphere in association with meteorological soundings.	1. A detailed study of the structure, winds, and composition of the ionospheric regions and beyond in the earth's atmosphere is underway by means of sounding rockets and earth's satellites. 2. The U.S.S.R. has already achieved the development of a routine rocket sonde for meteorological-type soundings into the lower portion of the upper atmosphere.
Ionosphere.....	Intensive rocket and satellite studies of the ionosphere in the F region and beond are underway.	Intensive rocket and satellite studies of the ionosphere in the F region and beyond are underway.
Magnetic field.....	The United States has used search coils saturable core magnetometers and proton precession magnetometers in its measurements of the earth's magnetic field. The United States is preparing to use a much more sensitive instrument, the alkali vapor resonance magnetometer, for further studies of magnetic fields in space and to measure the magnetic field of the moon.	The U.S.S.R. has also used standard-type magnetometers and proton precession magnetometers for observations of the earth's magnetic field. The U.S.S.R. has made a measurement to detect the lunar magnetic field, finding none to within the sensitivity of their instrument. It is not known whether the U.S.S.R. is preparing to use the alkali vapor magnetometer in the near future.
Cosmic rays.....	Balloon, sounding rocket, and satellite observations of the intensity, nature, and effect of cosmic rays are underway.	Balloon, sounding rocket, and satellite observations of the intensity, nature, and effect of cosmic rays are underway.
Radiation belt.....	Detailed study of the radiation belt by means of sounding rockets, satellites, and space probes, with occasional use of controlled experiments is underway.	The U.S.S.R. made intensive studies of the radiation belt in Sputnik III, but at the present time appears to be investigating the belt incidentally as part of their concentration on deeper space missions, namely on their lunik flights.
Aurora.....	United States scientists are tackling the problem of both visible and ultraviolet auroral radiations, the particles connected with the aurora, and the ultimate origin of the aurora.	The U.S.S.R. scientists are tackling the same problems.
Geodesy and celestial mechanics.	United States is continuing use of satellites for geodetic studies.	The U.S.S.R. shows skill in applications of celestial mechanics, as witnessed by their ability to launch Lunik III with the accuracy achieved, and to predict the motions of the Lunik III spacecraft.
Meteors.....	The United States continues to collect data on meteors in space, using a wide variety of experimental equipments.	The U.S.S.R. has made an intensive study of micrometeors in their satellites and space probes, appearing to attack the general problem very much along the lines followed by the United States.
Astronomy.....	Active rocket astronomy in-being. Orbiting telescopes, solar, and astrophysical observatories being worked on.	Unknown.
Lunar exploration...	The United States is preparing to conduct intensive investigations of the moon, but the actual observation of the moon from space vehicles is yet to begin.	The U.S.S.R. has already achieved significant steps in its investigation and study of the moon. It may be presumed that the Soviets will continue their vigorous effects in this area.

TABLE 3.—*Problems currently under attack*—Continued

Field	United States	U.S.S.R.
Planetary investigations.	United States has minimal capability in this area at present, and on the present schedule planetary work is proceeding at a very low pace.	The U.S.S.R. has an advanced capability in this area, and has declared its definite interest in planetary research.
Miscellaneous experiments.	United States using upper atmosphere regions for controlled chemical and Argus-type experiments. Also planning relativity and gravity experiments.	Unknown.
Biosciences and man in space.	The United States has a 1st stage man-in-space program in Project Mercury. Support work of a research type is being carried out in the DISCOVERER program. Some experimental work is being carried out in sounding rocket flights. A well-rounded, fully developed program of research in both biotechnology and biosciences is yet to be worked out.	The U.S.S.R. has a highly active program of research on animals under rocket flight and satellite conditions. It is not known how fully developed their biotechnical and fundamental biosciences programs are. It is expected, particularly from recent news releases, that the U.S.S.R. does have a man-in-space program.
Meteorology	The United States is developing rocket photographic techniques for meteorological purposes. The United States is developing a meteorological sonde for synoptic soundings. The United States is conducting fundamental satellite experiments associated with meteorology, and is taking the initial steps in the development of a meteorological satellite system.	The U.S.S.R. has already developed a working meteorological rocket sonde, which they have already put to extensive use. It is not known what the U.S.S.R. is doing in the matter of developing a satellite meteorological system.
Communications	In its rocket, satellite, and space probe telemetry the United States has shown good capability. Long-range communication systems are being worked on for deep space probes. Communication satellite systems are being worked on.	The U.S.S.R. rocket, satellite, and space probe telemetry has been successful. In particular the communications and telemetry problems of Lunik III appear to have been worked out with a high degree of competence. It is not known whether they are developing a communication satellite system, but it may be presumed that they are.
Navigation	The United States is working on a navigation satellite of high degree of refinement.	It is not known whether the U.S.S.R. is devoting effort to a navigation satellite.

RELEASES TO THE PRESS

Mr. JENSEN. Now, last but not least, it seems that we have an awful lot of self-appointed or so-called self-styled experts in Washington, D.C., and elsewhere throughout the country, who are constantly making charges to the effect that you, Doctor, and the Atomic Energy Commission and our military just do not know what they are doing, or words to that effect, or it amounts to about that.

It seems they are critical of our entire space program and our entire military program, they send out releases and they call in newspapermen and they have every kind of a session you could imagine, including hearings, especially in the other body.

Is that the main reason why you feel that you are dutybound to make so many newspaper releases to tell the American people the facts as you see them, and to counteract false information, or seemingly false information, that is put out by these self-appointed space and atomic and military experts?

Is that why you feel that you have to make so many newspaper releases to the American people?

Dr. GLENNAN. Mr. Jensen, I am sure that there is the need for the American people to be adequately and correctly informed on the programs which we are undertaking. However, in general, I refrain from trying to argue in the newspapers with statements that obviously

have little basis in fact. If a statement really needs to be corrected, we keep the record straight so the people do not get a lot of misinformation.

We really have tried, as Mr. Thomas points out we ought to try, to accomplish something before we talk about it.

Mr. JENSEN. To which I agree.

Dr. GLENNAN. We just live in a glass house and, by George, it is so you cannot keep people from looking in, and we thus find ourselves constantly under public scrutiny. I think this is, perhaps, the reason that we are trying to do a sensible job.

Mr. JENSEN. I may say, Doctor and Mr. Chairman, that I have been greatly disturbed many, many times when I read statements by men in high public office relative to your progress and our military situation, because I can see where most of those statements do much harm, by giving aid and comfort to the enemy.

I am afraid that those folks who make loose statements—and I say they are loose because I know they have been proven wrong many times—surely do not realize just what effect such unwarranted and incorrect statements have. I do not believe they understand the effect of them. If they did, they would not give out such statements. I know what the Communists do. You know what they do. When a Member of Congress or a man high in public office makes the statement that we are weak and that we are far behind and other such statements as that, the Communist newspapers spread it far and wide and the Communist radio spreads it far and wide and then regardless of what our Radio Free Europe says, it has very little weight, because what a man in high office in Government or any Member of Congress says is news, and it is taken in those foreign countries to be authentic. I cannot help but worry about it. I am sure you worry about it. I am sure Mr. Thomas worries about it. You never hear Mr. Thomas spouting off to the newspapers, giving statements which are incorrect. Why? Because he is a statesman. I wish some of these politicians would take a step backward and take a look at themselves before it is too late.

That is all, Mr. Chairman.

Mr. THOMAS. Thank you, gentlemen. It is certainly nice to see all of you, and we will see you in your regular program, I imagine, in the next 2 or 3 weeks.

I think your program is going all right.

INDEX

	Page
Appropriations for 1959 and 1960	23
Budget, development of	42
Construction and equipment	29
Launch pad at Atlantic Missile Range, modifications to	30, 34
Mercury tracking network	37
Station development and construction	31, 34
Radar sites	35
Employment:	
Excepted positions	6
Increases requested	4
Personnel ceiling	4
Public Relations, Office of	13
Press releases	53
Research and development	23
Lunar and planetary programs	11
Manned space flight program (Project MERCURY)	17, 25
Cost of program	27
Tracking network	37
Research grants and contracts	9
Soviet space program, compared with United States	45
Space program, benefits of	43